Design Engineering

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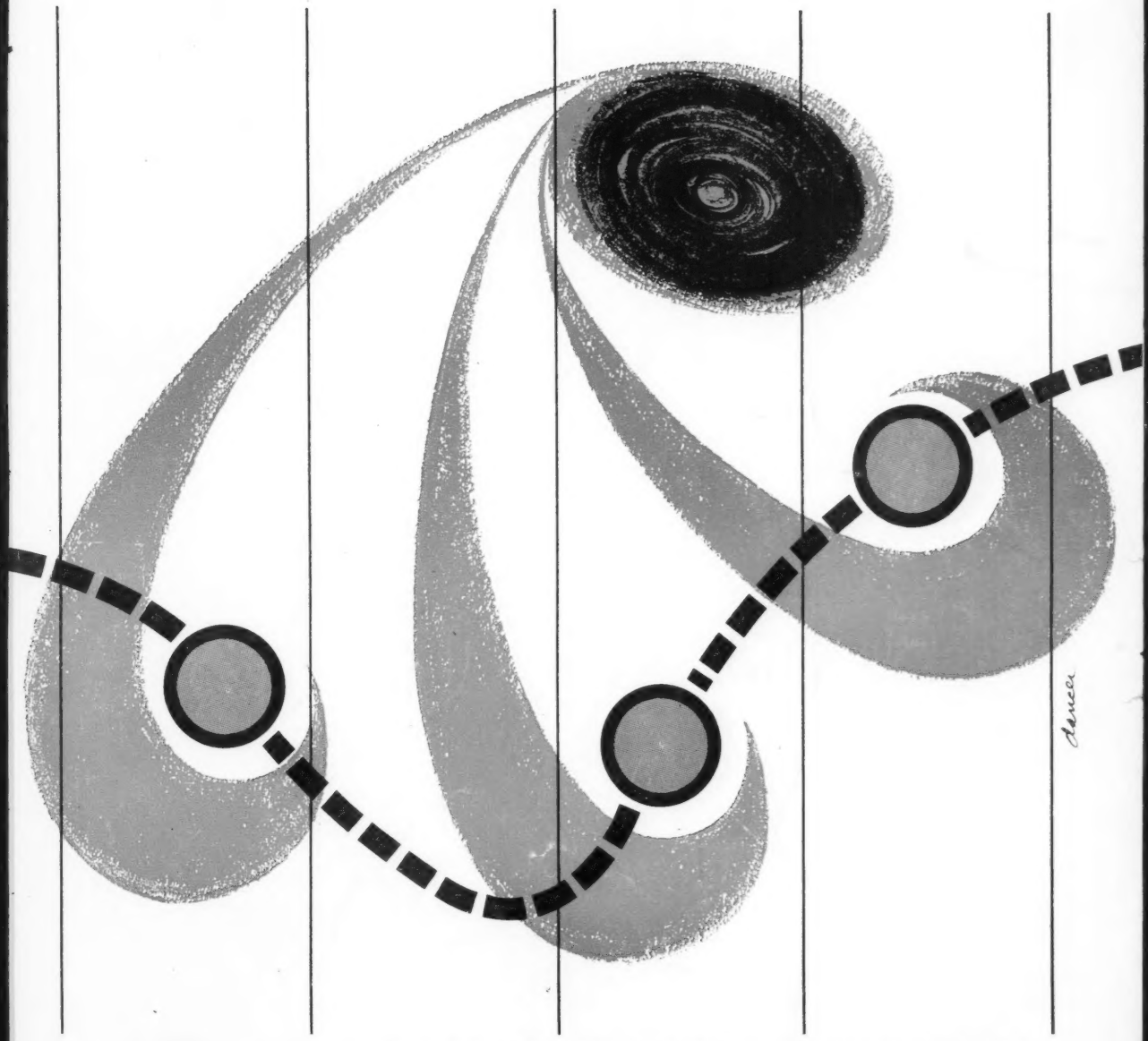


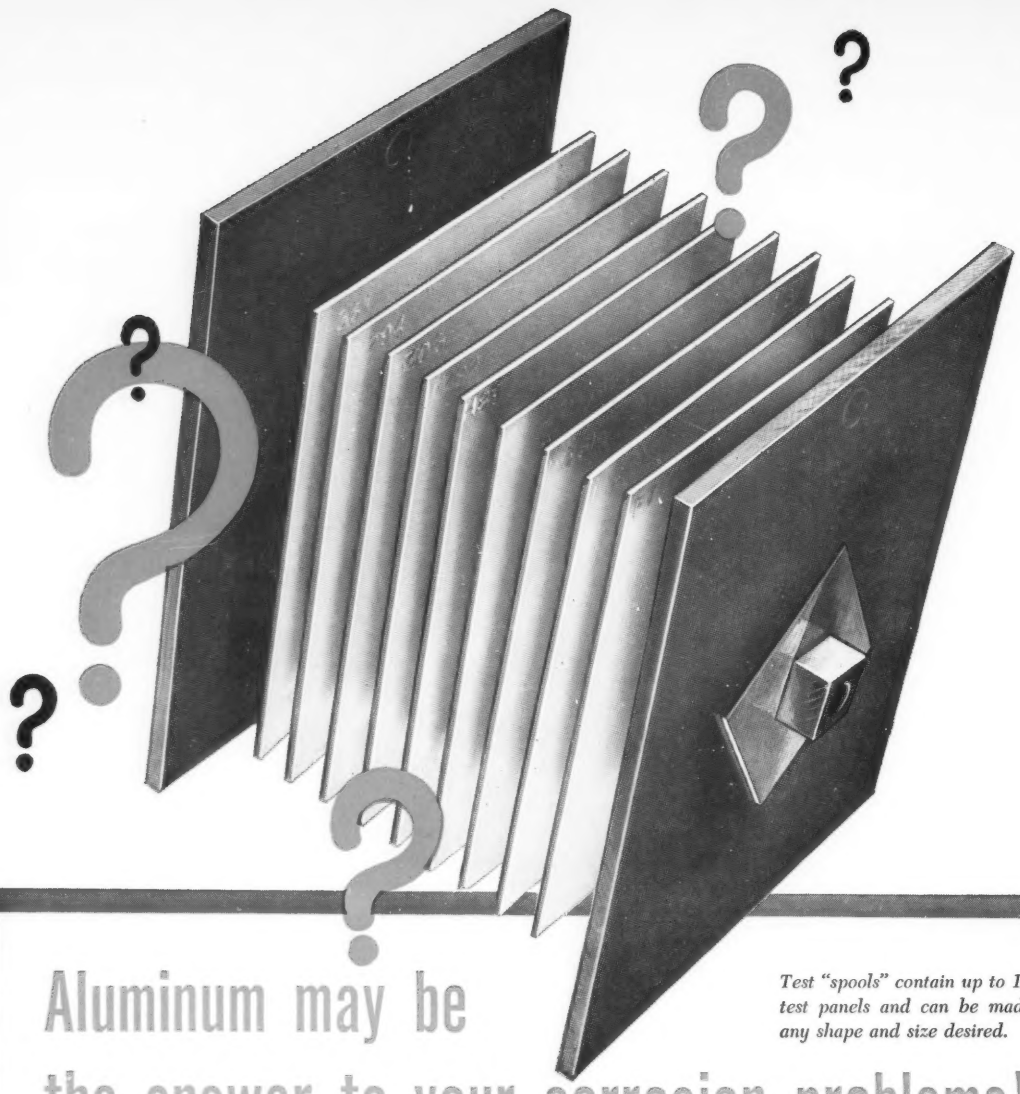
TRY PAINT SPRAYING AROUND CORNERS (page 34)

New free piston engine is cheaper

What is nylon to engineers?

April 1956

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA



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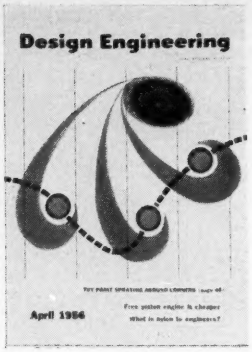

Design Engineering

VOL. 2 **APRIL 1956** NO. 4

This month's cover

Spray painting around corners by the electrostatic process is the cover subject for this month. The broken line and large dots show the conveyor belt with the items to be coated. The whorl at top is artist Don Dancer's interpretation of the spray nozzle and the octopus-like tentacles illustrate the paint path to the products. You will see that the editors have enlarged the type size of the cover headings for a more arresting layout. Inside the issue, we have used more headlines on the department pages than before. We hope you like these new features of Design Engineering.

Design Engineering

MEMBER

CCAB

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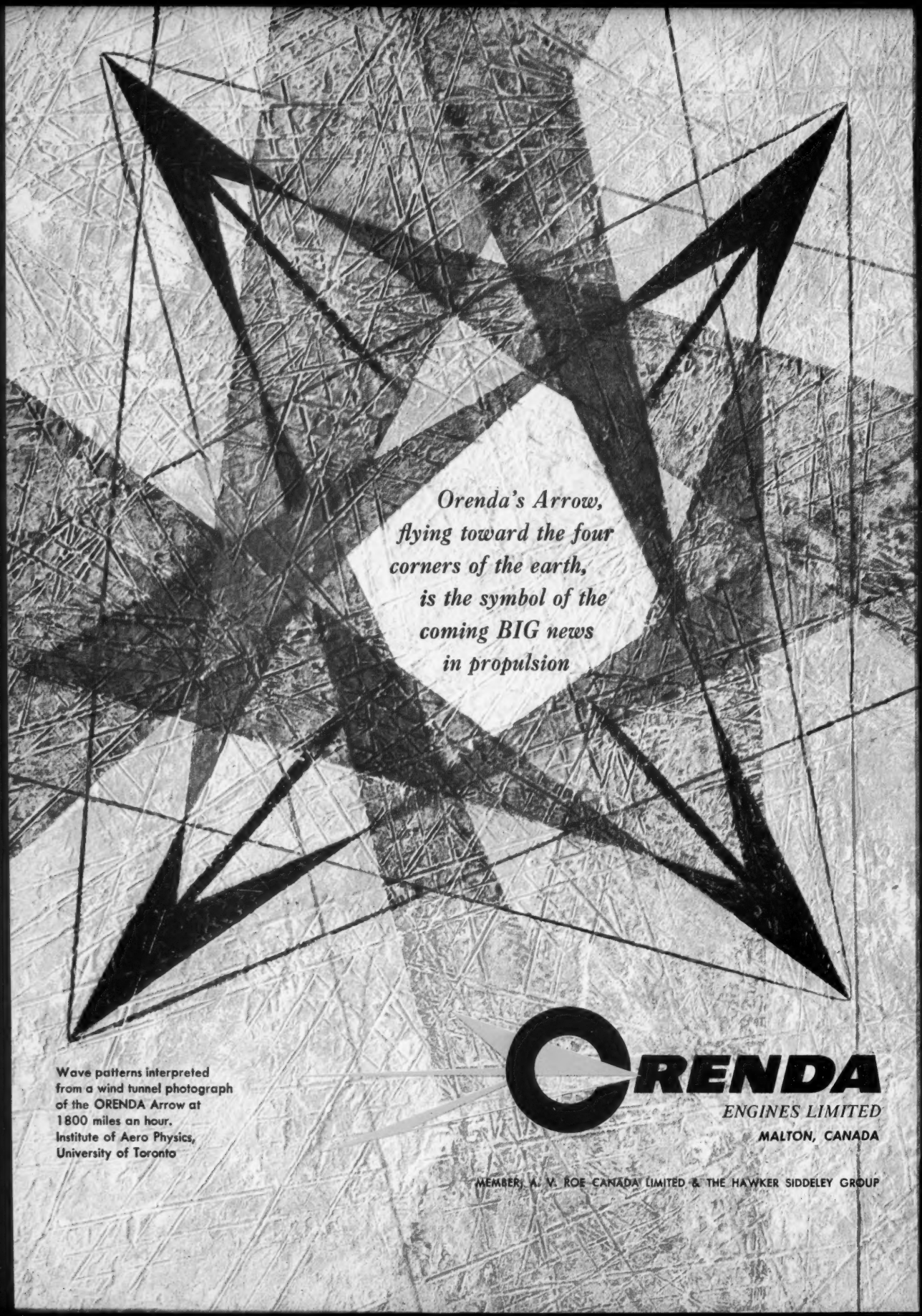

Wave patterns interpreted from a wind tunnel photograph of the ORENDA Arrow at 1800 miles an hour. Institute of Aero Physics, University of Toronto

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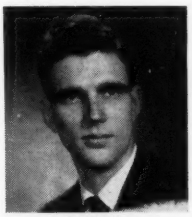
The **May** issue of **Design Engineering** will carry strong feature articles written by contributors no less experienced than those featured this month.

Modular (or unit) Design in Electronics will be our lead feature, which tells of a method of building up components in electronic design.

A broad report on Infra Red detection which is being given more and more attention by designers is another well-developed story.

And an unusual article that deals with Explosive Rivets will be in our next (May) issue.



Whitely

Keith Whitely, who wrote the article on Electrostatic spraying (page 34) is English-born and came to Canada when he was three. Educated at Toronto's Vaughan Road Road Collegiate he went on to Toronto University where he took Honor Chemistry Joining C-I-L in the paints division after graduation, he has been connected with the paints research laboratory in the development of finishes for automobiles. His hobbies are golfing, skiing and "tinkering with cars." Married, he has a home at Agincourt in suburban Toronto.

Naujoks

Waldemar Naujoks, a drop forgings specialist is on the staff of the Drop Forging Association where he heads the statistical program. He was born in Wisconsin and graduated in metallurgy from the state university there. Later he got his mechanical engineering degree and supplemented his technical education with several business and administrative courses. He is married and has three children. His artcle on Drop Forgings is on (page 42).

Shapiro

Born in Poland, Jacob Shapiro, author of Free-piston Engines (page 48) started his technical training with machine tool manufacturers near Berlin. A graduate of the Federal Institute of Technology at Zurich in 1935, he wrote his thesis about free-piston engine development. His professional life began in Haifa, Palestine where he was a designer draughtsman in general engineering and power station work. Thence to France he was in aviation and in 1940 joined Sir Frank Whittle's pioneeer team as research engineer at Power Jets Ltd. Associated next with helicopters, he became chief technical officer of the Cierva Autogiro Co. Now a consulting engineer, he heads a design team on helicopter projects. He is a founder of the Helicopter Assoc. of Great Britain.

Walsh

Nylon-Zytel expert James A. Walsh is author of the story about nylon molding resins (page 29). As a technical service representative for Du Pont of Canada he keeps molders of the company's plastic materials up to date on production and design developments. A native of Montreal, he served three years with the RCAF. He is an engineering graduate of McGill University and now lives in Toronto.

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Reports

Toronto chosen scene for 1956 AMA meet

First time outside the USA Seminars come to Canada

TORONTO — Seminars dealing with electronic data processing, administration of the maintenance function, and the function of marketing research in industry are scheduled by the **American Management Association** here April 23-27.

This is the first group of educational meetings for business executives ever to be conducted outside the United States by the AMA.

Nearly 300 businessmen from all parts of Canada will take part in thirteen three-day seminars, each devoted to specific problems in finance, marketing, manufacturing, and personnel.

The association will conduct more than 500 meetings in various fields of management this year, most of them in New York.

The seminars here were scheduled to give industrial leaders of Canada an opportunity to participate in an international educational program that is within convenient reach of their local operations.

• • •

Helicopters to prospect Will carry research device

OSHAWA — A NEW RESEARCH and development laboratory has been established at Oshawa Airport by **Aeromagnetic Surveys Limited,** which will work on geophysics equipment similar to the company's airborne electromagnetic (EM) devices.

General manager of the establishment is Douglas MacKay who says airborne EM instruments designed and developed by the parent company, PSC Applied Research, are credited with discovering several proven ore bodies in New Brunswick last year.

"Although company security prevents the listing of these bodies," manager MacKay said, "I can reveal that they include that of the Middle River Mining Co., and also that of Kemco Explorations (Canada) Limited."

In total value, he estimated these finds have added many millions to the Canadian natural wealth.

A newly designed EM unit, specifically made for helicopters has been tested in Northern Ontario by the new laboratory.

"This new helicopter EM method will permit opening up of areas that until now could not be explored for electrically-conductive base metal ore deposits," manager MacKay explained. Aircraft must fly at a 500 ft. altitude to make a survey and in some areas this is not possible with larger aircraft. The EM equipped helicopter will overcome this difficulty.

The company's aircraft kept at Oshawa Airport include five Canso's, considered flying geophysical laboratories, which are the only aircraft in the world equipped to make a combined EM, magnetometer and scintillation counter survey at the same time.

• • •

Avro, Orenda aid students Establish 14 scholarships

MALTON — ENGINEERING STUDENTS at Toronto, Queen's and McGill universities, particularly those who specialize in aeronautics, will benefit beginning this spring from fourteen $500 scholarships offered jointly by **Avro Aircraft** and **Orenda Engines Ltd.**

Eight of the scholarships are being established at Toronto, and three each at McGill and Queen's. Of the total scholarships, nine are accompanied by $300 grants to the universities.

Avro is also going to offer three $500 scholarships each year, starting in 1956, to the child or ward of an employee of the company to provide four years tuition at Toronto. A design prize of $50 for the student with the highest standing in the fourth year Aircraft Design will also be established by the company.

And, in addition, Avro will set up a students loan fund of $3,000 over the next three years to help needy engineering students at Toronto at the discretion of the university.

• • •

West's steel needs increase Bridge company keeps pace

VANCOUVER — Facilities for the fabrication of light and heavy platework at the plant of **Dominion Bridge Co. Ltd.** here have been expanded following the opening of a new plate shop.

The enlarged facilities will keep the company's Pacific division abreast of the West Coast's industrial development. In particular, it puts Dominion Bridge in a better position to provide the increasing steel requirements which coincide with the major advances in the pulp and paper, oil refining, hydro-electric and petro-chemical industries.

Modern equipment installed in the new building includes a new 800-ton press brake manufactured by an associate company, Dominion Engineering Works Ltd.; heavy rolls; straightograph edge preparation equipment and other machinery. The shop is also equipped with the latest in X-ray equipment.

Two years ago, a large stress relieving furnace, only one of its kind in B. C., was installed at Burnaby. It is required for the manufacture of large welded vessels which meet highest requirements of the ASME code. Vessels for oil refineries and chemical plants and pulp and paper mills are typical examples.

Guests inspect new platework shop at Dominion Bridge.

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THE LATEST NEWS IN PRINTED CIRCUITS

New HP Series Copper Clad Laminates Give Double Bond Strength—Assure Perfect Circuits In Less Dip Solder Time

Bond strength—12 to 15 pounds! Dip solder temperature resistance—30 seconds at 500°F.! These unique features of National's new HP Series of copper clad laminates may well revolutionize printed circuits.

Base of these laminates is National's PHENOLITE® laminated plastic—most widely used material for printed circuits. To this we apply a new surface conditioning process and a super-strong bonding adhesive. Result; faster processing and fewer rejects—better printed circuits than any made by other methods.

In production, HP Series laminates speed dip soldering and provide cleaner joints. In service, they minimize bridging in the printed circuit. The high heat resistant bonding adhesive also assures unusual retention of bond strength—even after repeated heating and cooling, which occurs in electronic circuits when current is turned on and off.

Manufacturers using automatic assembly machinery will find HP series clad laminates especially useful. The new process uniformly conditions the bonding surface of both electrolytic and rolled copper foil. And the speed-up in soldering, *without* sacrificing perfect connections, permits production line assembly of printed circuits—particularly when cold punching grades of PHENOLITE are used.

WRITE FOR NEW HP SERIES EDITION—PRINTED CIRCUIT CATALOG. Etchers and users of printed circuits will find the key to better production, reduced costs and improved products in our new HP Series manual "Mechanize Your Wiring." Write for free copy to Dept. N-4.

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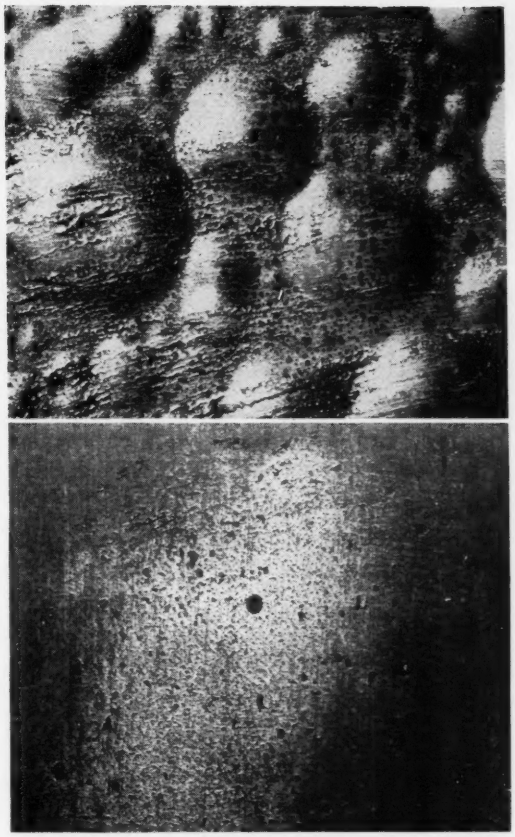
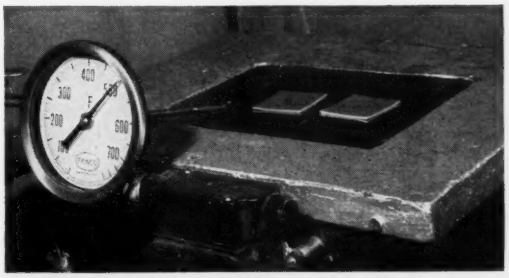
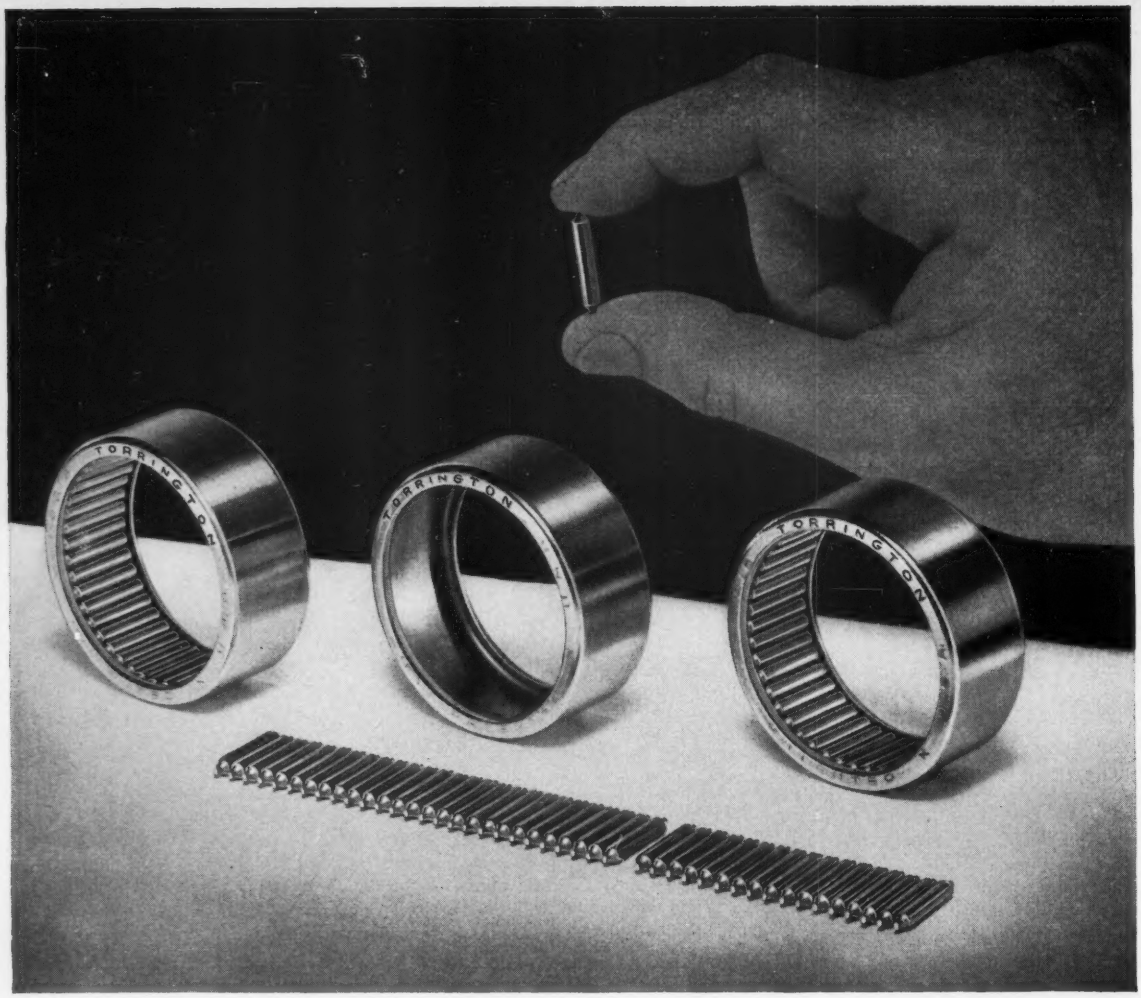


Unretouched photographs show effect of 5 seconds dip soldering at 500°F. on conventional copper clad laminate and 30 seconds at 500°F. on the new HP Series laminates made by National Vulcanized Fibre. Note severe blistering of conventional laminate (top) and the virtually unmarred surface of National's HP Copper Clad (bottom).



At 500°F., 5 seconds in a dip solder bath is enough to ruin ordinary printed circuit laminates. Bonds lose their strength. Cladding develops blisters. Production becomes impossible. But *not* with new National HP Series Copper Clads. These take the punishing temperature for up to 30 seconds—without damage.



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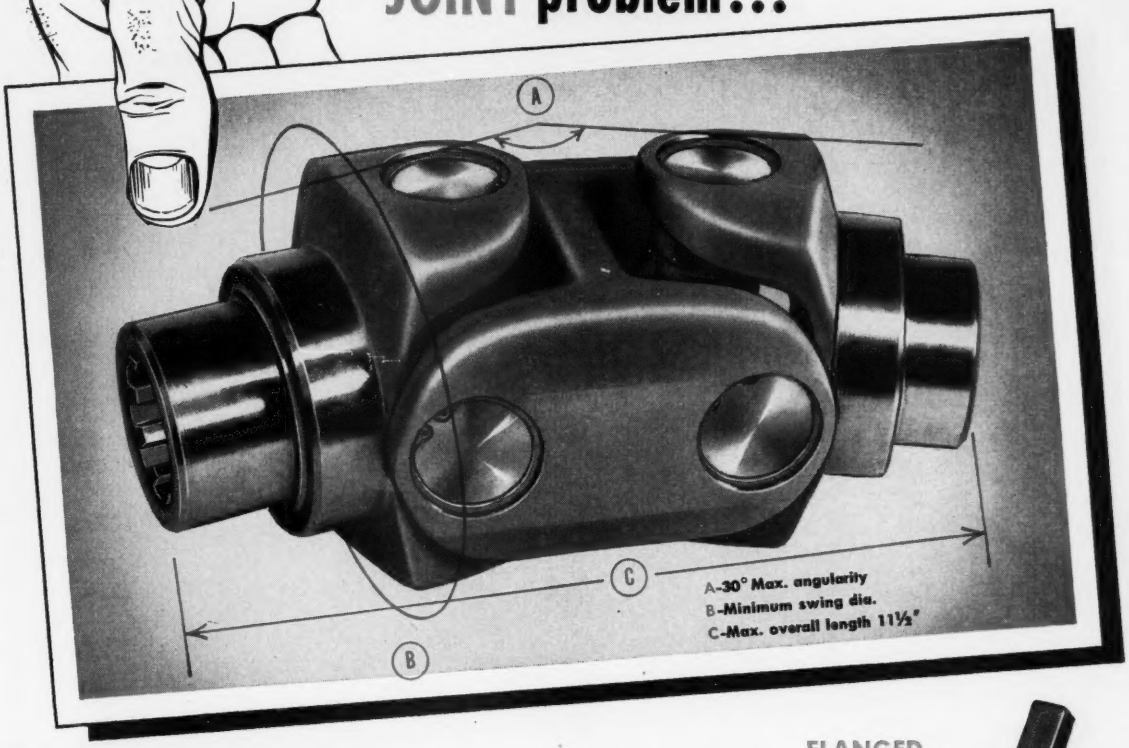

PROBLEM: A well-known product engineering firm, designing a specialized mobile, diesel-driven machine, required special universal joints to transmit power to rubber-tired all-steering wheels. Joint length and diameter were limited by unusual space restrictions, yet heavy torque loads were expected at angles to 30°.

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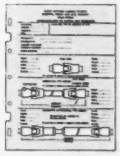

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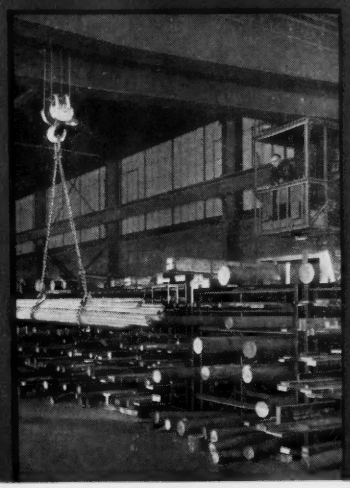

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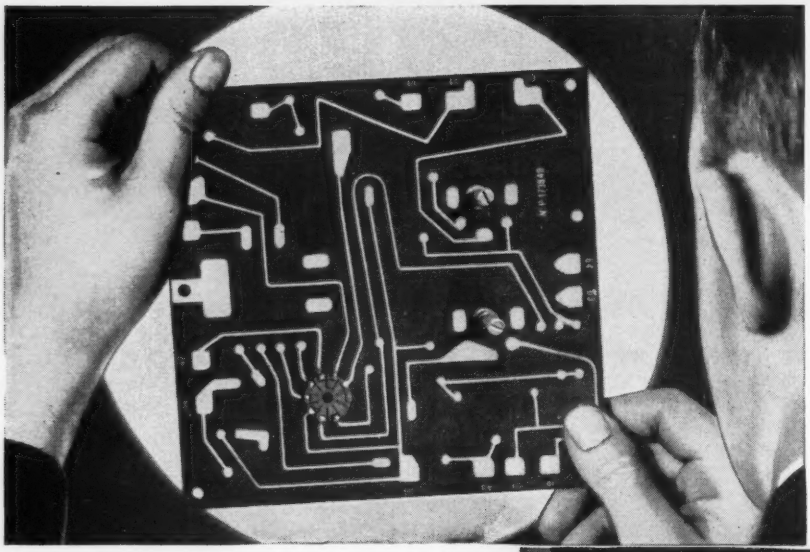
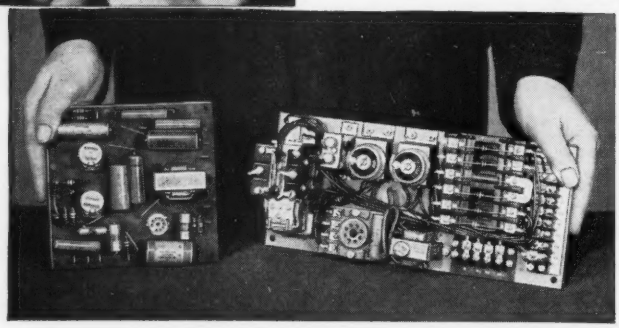


Shown here is the "brain" of the new general purpose G-E Thy-Mo-Trol Drives. Here an electrical diagram, or electrical "track", is printed on the back of a sturdy plastic board. This "track" consists of solder-covered copper strips which connect all circuit components without the use of wiring.

NOW! GET RELIABLE, SMOOTH, ADJUSTABLE SPEED FOR MACHINE TOOLS IN A SIMPLIFIED LOW-PRICED DESIGN!



Here is ample evidence of the simplicity and reduced size made possible by the new G-E printed control circuit system, left. At the right is the conventional type. Note its larger size and complexity.

By adapting printed or "wireless" circuits to a completely new line of G-E* Thy-Mo-Trol Drives, C.G.E. offers industry electronic adjustable speed drives at up to 20% reduction in cost.

These drives consist of an electronic control panel, a DC motor, and a push-button station. The big price difference is made possible by the use of printed circuits in the control panel. Designed for quality performance, reliability and easy maintenance, these G-E Thy-Mo-Trol drives are available in two ratings: ¾ to 1 hp and 1½ to 3 hp. They feature reductions in weight, size, circuit complexity, wiring, and maintenance and installation costs. They supply constant torque over the entire speed range, which is 8 to 1, with higher ranges possible for special applications.

For further information on these outstanding new low-cost drives, contact your nearest C-G-E office or write to: Apparatus Department, Canadian General Electric Co. Ltd., 212 King St. West, Toronto, Ont.

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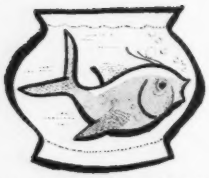
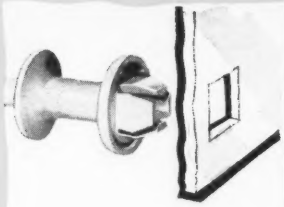
1425 Mountain Street, Montreal 25
Telephone HArbour 3145

Here's Why
SHAKEPROOF PLASTIC FASTENERS
Do A Better Job At Lower Cost!

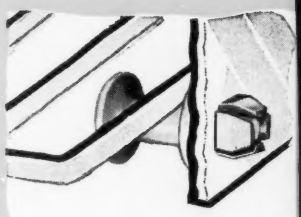


1. NON-CORROSIVE
Shakeproof Plastic Fasteners won't rust . . . often eliminate expensive corrosion-resistant metal fasteners.

In refrigerators, for example shelf supports must be completely rust-proof, easy to install, and very sturdy.

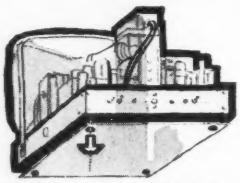


Shakeproof Plasti-Supports. Have the fastening action of a rivet . . . drive from one side only.

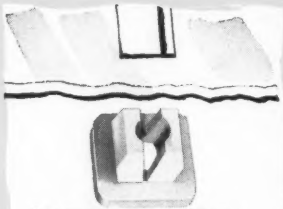


Won't chip or crack porcelain enamel. Save appliance manufacturers thousands of dollars yearly.

2. NON-CONDUCTIVE
Shakeproof Plastic Fasteners are made of excellent dielectric materials. They're self-insulating, often eliminate extra fasteners.



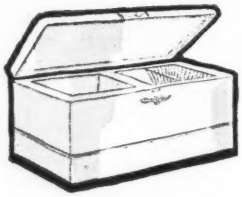
Mounting a "hot" TV chassis is critical. Manufacturers formerly used expensive bracket-to-bracket mountings.



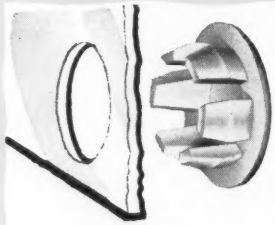
Now, Shakeproof Plasti-Grommets eliminate these complicated devices. Simply snap them in, then drive a screw to spread the legs.

Plasti-Grommets install from one side . . . withstand loads of 500-600 lbs. . . . can save thousands of dollars on your production line.

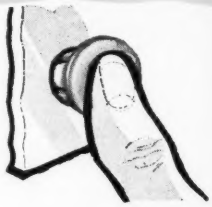
3. COLOR-MATCH
You name the color . . . Shakeproof Plastic Fasteners will be matched to your color specifications.



In modern appliance, color-match is important to appearance when plugging left-over production holes.



Use color-matched Plasti-Plugs here and save the cost of expensive rack painting. They won't scratch or rust.



Just snap them in . . . and save yourself many production costs and headaches in matching colors.

Free Descriptive Literature

See for yourself how you can cut assembly costs and production time . . . and have a higher quality product. Drop us a note and we'll gladly send you complete descriptive literature on Shakeproof Plastic Fasteners.

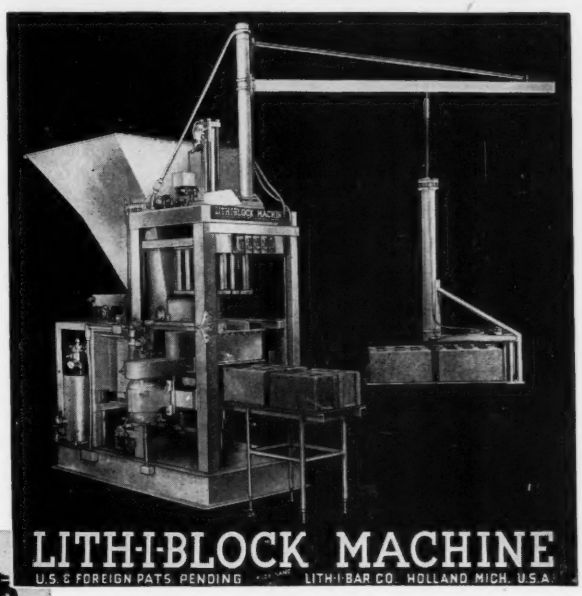
CANADA ILLINOIS TOOLS, LTD.

177 Front Street, East
Toronto, Ontario

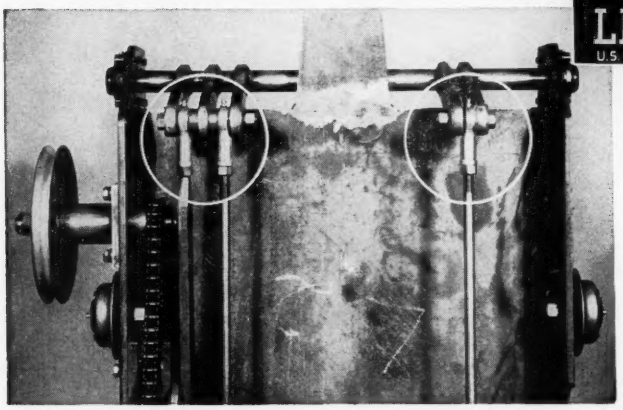
WORLD'S BROADEST LINE OF MASS-ASSEMBLY FASTENINGS

HEIM *Unibal* Spherical Bearings

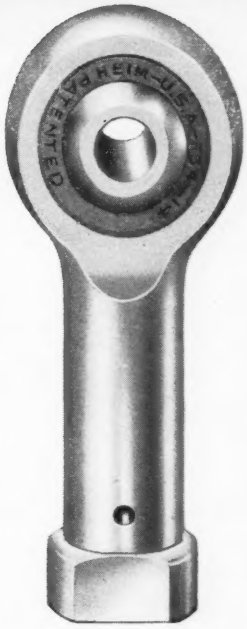
help speedy production of concrete building units



The Lith-i-Bar Company, Holland, Mich. manufactures this machine for the high-speed production of concrete building units — over 7,000 blocks per day. The rod ends shown on the "feed drawer" are *HEIM* — naturally.



This is the
HEIM
Unibal
Spherical Bearing
ROD END
with the amazing single ball bearing principle.



The Lith-i-Bar Co. says: "We are most pleased with the results, and don't mind admitting that previous to the adaptation of your units, we did encounter considerable difficulty in parts involved in this mechanism."

Whenever you think of transmitting motion at varying angles, think of HEIM.

Engineering data are complete in the new Heim catalog — please write for your copy.

R&M BEARINGS CANADA LTD.

QUEBEC CITY	MONTREAL	WINNIPEG	THREE RIVERS	TORONTO	VANCOUVER	LONDON, ONT.	HAMILTON
755 Blvd. des Capucins	1006 Mountain St.	1302 Notre Dame Ave.	375 St. Georges St.	50 Edward St.	1066 Seymour St.	1024 Oxford St. East	130 Ferguson Ave. N.

FACTORY REPRESENTATIVES AND DISTRIBUTORS FOR CANADA

DESIGNERS' DELIGHT

Almost every design problem is a problem of materials. Is the price right . . . is it strong enough . . . light enough . . . colourful and bright enough? Can it be cheaply formed and produced at speed . . . is it resistant to corrosion, rust, denting or scratching?

That's why so many design problems simply cease to exist when the designer begins his planning with a full appreciation of what can be done with Fiberglas Reinforced Plastics.

F.R.P. could be the answer to your problem

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FIBERGLAS CANADA LIMITED

FIBERGLAS CANADA LIMITED
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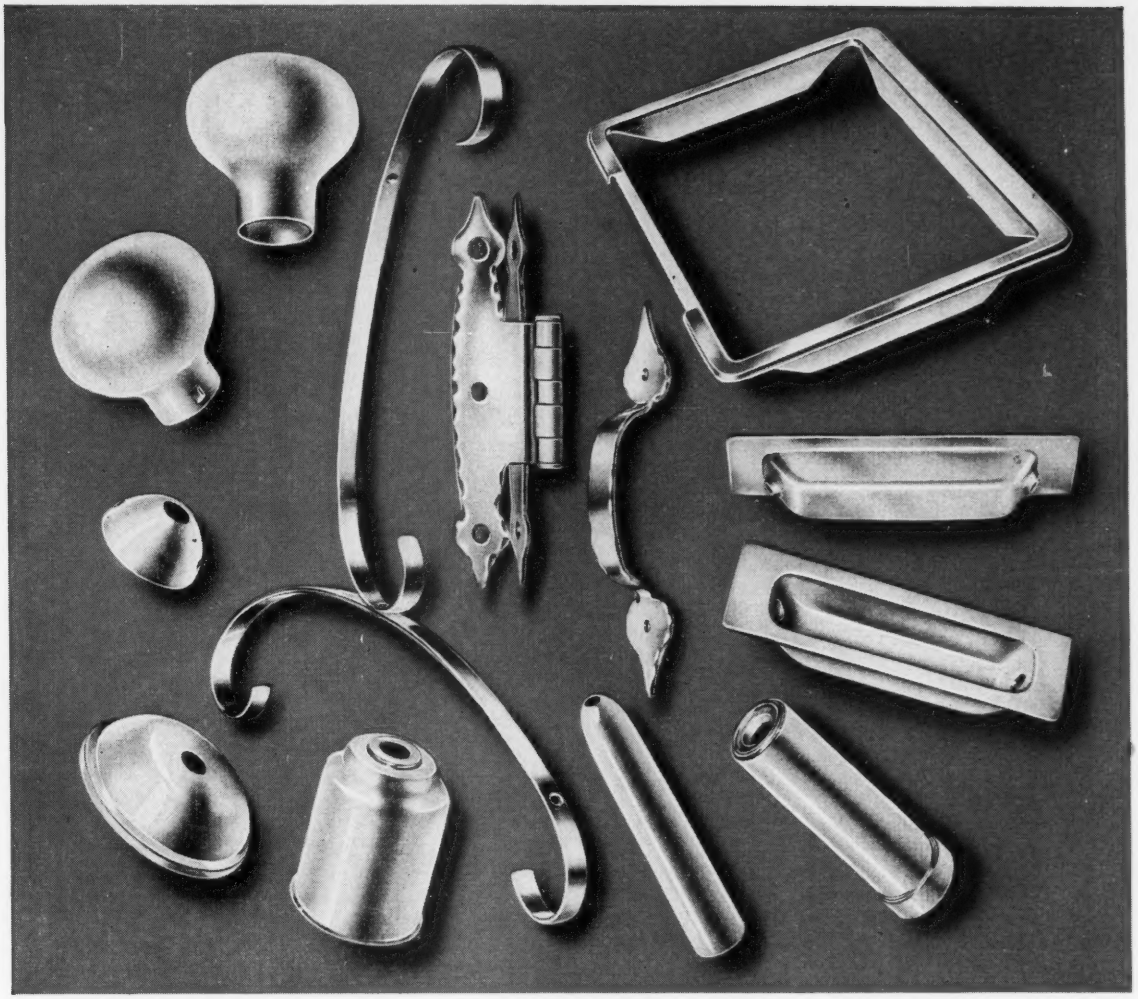
IT'S AMAZING THE DIFFERENCE FIBERGLAS MAKES!

A SHORT CUT TO A FINISHED PRODUCT



CUT POLISHING COSTS IN HALF WITH "Formbrite"

the new superfine-grain drawing brass with the built-in finish

The secret is in the grain: Special methods of rolling and annealing produce in Formbrite a grain structure so fine that often a simple color buff will bring it to a bright, lustrous finish.

Formbrite is also harder, stiffer, springier and more scratch-resistant—yet it is surprisingly ductile, readily stamped, formed, drawn, and embossed. And Formbrite plates beautifully.

More and more companies are using Formbrite to cut their polishing costs and get superior products—at no extra cost over ordinary drawing brass. They often save more than the cost of the metal itself.

A Lighting Products Maker: Reports savings in polishing cost of from 26% to 55% in various components of his high-quality, solid brass lighting fixtures. Work pile-ups were eliminated in the polishing room, too.

A Container Manufacturer: Rejects after polishing dropped from 11% to under 1% after switch to Formbrite in frames for "jewel-box" case for an electric shaver. A better finish in one faster pass through the automatic polishing machine.

A Metal Products Firm: Polishing costs cut 40% in deep-drawn pen, pencil, and lipstick cases. Uniformity of Formbrite eliminated shutdowns for adjustments in long-run production.

A Specialty Producer: Saved enough in polishing cost to avoid price increases —despite increased labor and material costs. Reports Formbrite fabricates almost as readily as the softest drawing brass . . . uniformity of gauge in Formbrite has simplified manufacture.

Find out for yourself how Formbrite can serve you as a short cut—save you money. Write for Publication B-39. Address: Anaconda American Brass Limited, Main Office and Plant: New Toronto, Ont. or Montreal Office: 939 Dominion Square Building.

ANACONDA

***FIRST* in Canada**
for Copper, Brass and Bronze

Stepless Speed Changes

LOW SPEED *to* High Speed

ALLIS-CHALMERS
Variable Speed
DRIVES

Vari-Pitch Sheaves Give You Variable Speeds at Low Cost

For occasional stepless speed changes, Stationary Control, *Vari-Pitch* sheaves give you the correct operating speeds for maximum efficiency at lowest possible cost. You need no special motors, no elaborate equipment! By using *Vari-Pitch* drives, you get the speeds you want by means of a simple, 2-minute adjustment.

IT'S AS SIMPLE AS THIS!

Merely stop the motor, release the belt tension, turn the adjusting nut with the spanner wrench to the desired pitch diameter, restore proper belt tension and start the motor!

Stationary Control *Vari-Pitch* sheaves are available for standard belts (speed changes up to 25%) or wide range belts (speed changes up to 100%).

MOTION CONTROL AVAILABLE.

For frequent stepless speed changes, Motion Control *Vari-Pitch* sheaves permit speed adjustments while the unit is in operation. These sheaves are available for standard belts and permit up to 25% speed variation.

Contact the CA-C Sales Office nearest you for complete information on how *Vari-Pitch* sheaves can help you to maintain correct operating speeds, or write today to Canadian Allis-Chalmers Ltd., P.O. Box 37, Montreal, Que., for bulletin 20B7499B.

Vari-Pitch is an Allis-Chalmers trademark

Made in Canada

CANADIAN ALLIS-CHALMERS

B-CAR-1

DU PONT CANADA

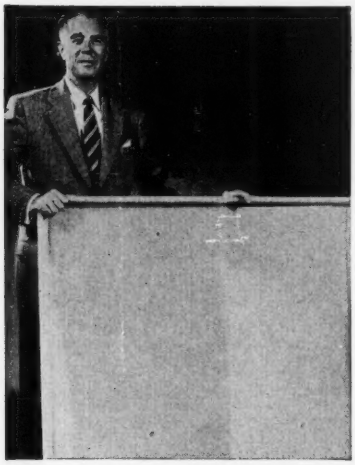
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Plax (Canada) Ltd. Chooses "Alathon" 10 for Heat Resistance in Boilable Bottle

Extruded Du Pont LUCITE® is specified for well-engineered lighting effects

LUMINOUS ceilings and modular panels of "Lucite" acrylic resin can be fabricated in many beautiful designs. Extruded sheets of "Lucite"—flat, corrugated, or formed—make durable, permanent, and efficient light-diffusing ceilings. Panels are extruded in widths of over 4 feet in clear or translucent white colors

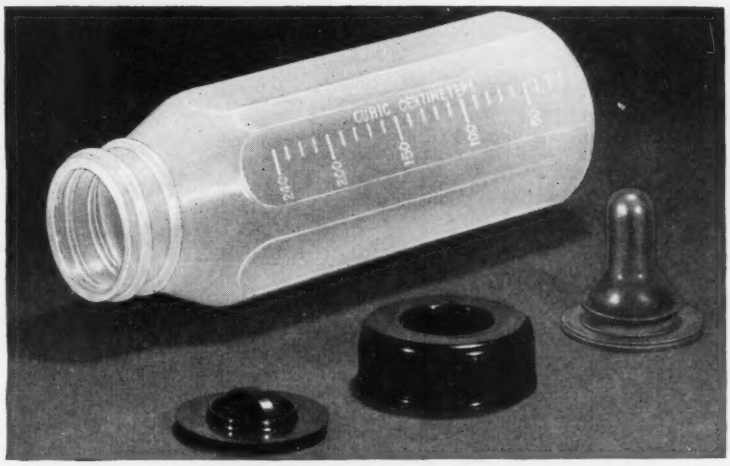


Large 4 x 4 foot modular unit of extruded "Lucite". This unit transmits shadow-free light without glare. Panels of "Lucite" are available in many sizes—and in both clear and translucent colors.

which faithfully and efficiently transmit a comfortable light of low brightness.

"Lucite" transmits optimum light yet cuts down glare. It has excellent impact strength and maintains its original color. Clear and translucent white "Lucite" is stable in direct outdoor sunlight—makes an ideal material for glazing, outdoor lighting fixtures, and skylights. Fabrication is economical; maintenance is easy.

Extruded "Lucite" is now available to design engineers in increasing quantities. Use the coupon on the back of this page for complete information on beautiful, long-lasting Du Pont "Lucite".



All the desirable properties of polyethylene can be used in this application because of the higher heat resistance of "Alathon" 10, Du Pont's brand of polyethylene

The combination of useful properties obtainable at reasonable price has made polyethylene (or polythene as it is widely known) just about the most versatile of all the modern plastics. Nevertheless, like all materials, it has certain properties in a degree which limits its application.

Corrugated extruded sheet of "Lucite" for light-diffusing ceiling. "Lucite" has excellent durability . . . maintains its beauty and original color indefinitely.

One of these has been heat resistance, a problem which confronted Plax (Canada) Limited when they endeavoured to produce a marketable polythene baby bottle. Most polyethylenes available lost strength rapidly at temperatures over 150°F. Improvements in this property were made only at the expense of other desirable properties.

Recent and still continuing research by Du Pont has indicated that substantial improvement can be made in the heat resistance of polyethylene without sacrifice of other properties. We will hear a lot more about this in the future but in the meantime, Du Pont are offering commercially several polyethylene resins and compounds having a heat resistance in the order of 25°F higher than designers are accustomed to.

Advantage of this property has been taken by Plax (Canada) Ltd., manufacturers of the familiar "squeeze bottle" in producing this baby feeding bottle which can be sterilized by boiling in the usual way without loss of

OVER

DU PONT CANADA

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

"Alathon"

(Continued from Page 1)

shape. Thus it has been possible to provide, in this use, all of the other desirable properties such as lightness, and unbreakability, without sacrifice of important consideration which would have resulted from the use of other polyethylene materials.

The material is known as "Alathon" 10 polyethylene resin. It is characterized by its higher strength, improved stiffness, complete lack of odor, and glossy finish in addition to its higher heat resistance.

"Alathon" 10 is only one of a series of new polyethylene resins all having sharply improved properties for use in packaging materials, pipe, wire and cable and general molding applications. It will pay you to design around these properties. Use the coupon for further details.

Investigate Du Pont engineering materials in your product development programs

ONE of the family of these versatile engineering materials is often a key factor in product improvement or new design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"† nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

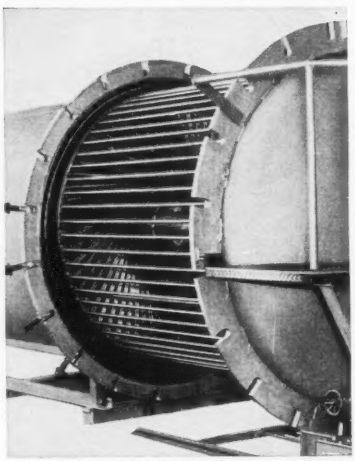
New dyeing machine has bushings of Du Pont TEFLON® to resist high heat and pressure

RECENTLY, a new machine called the "Barotor" was developed for dyeing synthetic fabrics. The "Barotor" improves the dyeing of synthetics by utilizing high temperatures and pressures. The designers were faced with the problem of choosing a material to be used for the bushings which carry the many stainless steel cross bars. These bushings could not be affected by the dyeing process, and should be able to function without lubrication.

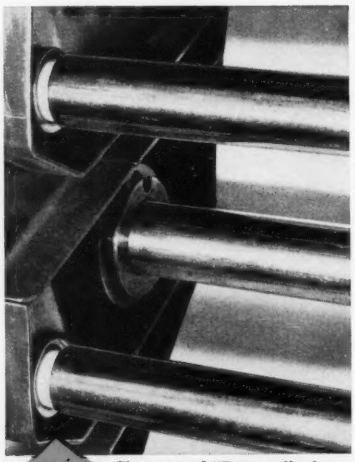
"Teflon" Solves Problem

Bushings of "Teflon" tetrafluoroethylene resin were the answer. These bushings are unaffected by the high operating temperatures of the "Barotor" and the 25 lbs. per square inch pressure used. The corrosive chemicals in the dye solution can't corrode these bushings, as "Teflon" is chemically inert. As this unique engineering material is self-lubricating and has a very low coefficient of friction, the problem of lubrication was eliminated. Wear on both the bushings and the cross bar was minimized. Result: Frequent replacement of parts is eliminated, and a substantial saving of time and money is achieved.

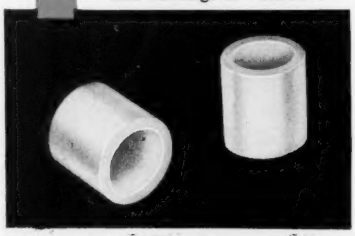
"Teflon" is another in the Du Pont family of engineering materials which has a tremendous potential in the textile industry. For additional data on any of these Du Pont engineering materials, fill out the coupon below at the left.



The new "Barotor" for dyeing synthetic fabrics uses heat- and pressure-resistant bushings of "Teflon" . . . gives smooth operation despite corrosive chemicals in dye solution.



Close-up of "Barotor", showing stainless steel cross bars and bushings of "Teflon".



Bushings of Du Pont "Teflon", formed by economical extrusion techniques.

DE-4

DU PONT COMPANY OF CANADA LIMITED,
CHEMICALS DEPARTMENT, P.O. Box 660, Room A-3, MONTREAL, QUE.

Please send me more information on the Du Pont engineering materials checked: ☐ "Zytel"; ☐ "Alathon"; ☐ "Teflon"; ☐ "Lucite". I am interested in evaluating these materials for.....

*NAME*_____ *POSITION*_____

*COMPANY*_____

*STREET*_____

*CITY*_____ *PROVINCE*_____

*TYPE OF BUSINESS*_____

*†T.M. Reg. U.S. Pat Off.

The less they have to work, the better!...

HERE'S ONE PLACE where cobwebs would be strictly O.K.—on piping maintenance tools. For the less they have to work, the lower your maintenance costs. Excessive valve maintenance is serious simply because the average plant has so many valves. So it's sound economics and good business to buy quality and low maintenance rather than "bargains" and frequent maintenance.

Naturally, the thrifty buyer always chooses quality valves, and for biggest value he insists on Crane. There's no greater assurance of dependable, low-cost performance . . . and the Crane line provides such quality in valves for every need.

For complete information on the Crane Valves to meet your particular requirements, ask your Crane representative, or Crane Branch—or write

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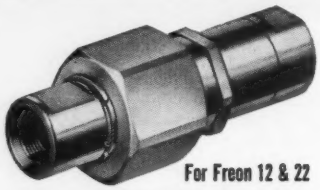
NATION-WIDE SERVICE THROUGH BRANCHES, WHOLESALERS and PLUMBING AND HEATING CONTRACTORS

Fluid Systems That Need Frequent Disconnection

NEED AEROQUIP SELF-SEALING COUPLINGS

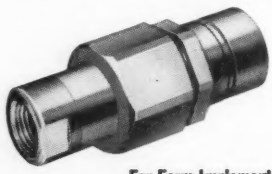


For Freon 12 & 22

Aeroquip 511017 Self-Sealing Coupling for refrigeration and air-conditioning applications makes low cost field installation possible by permitting factory charging of the units and lines of various lengths. Mates with sweat-type adapters.

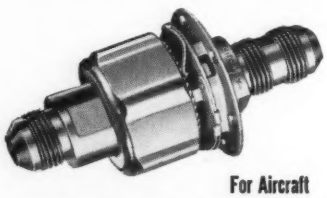
For LP Gas

Aeroquip 5102 Self-Sealing Coupling speeds recharge of LP-Gas fuel tanks on trucks, tractors. Coupling has Acme and P.O.L. threads to fit any recharge line. Absolutely no leakage of fuel upon connecting or disconnecting.



For Farm Implements

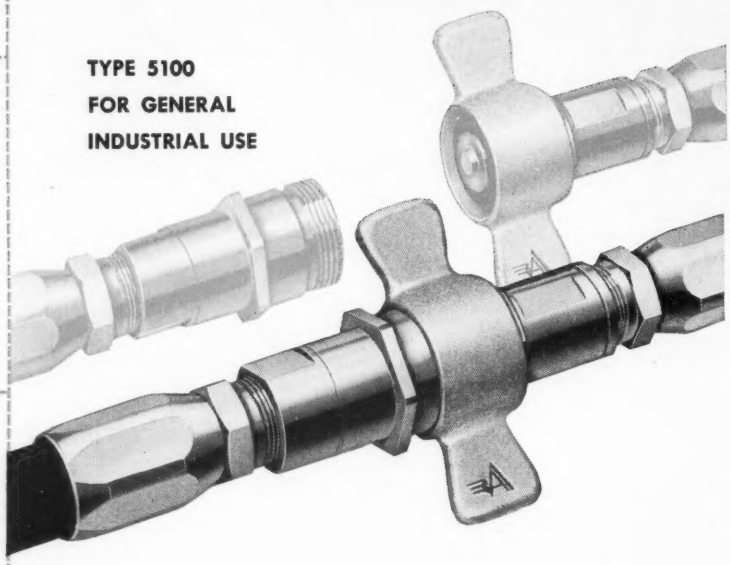
Aeroquip 5203 Self-Sealing Coupling provides quick, easy interchange of hydraulic trailing and tractor-mounted equipment. Mates with the Aeroquip Breakaway.



For Aircraft

Aeroquip 155 & 145 Self-Sealing Couplings speed inspection, servicing or replacement of engines and other aircraft fluid system components. Ideal for engine test stands.

TYPE 5100
FOR GENERAL
INDUSTRIAL USE



Aeroquip Self-Sealing Couplings permit quick connection and disconnection of fluid lines under pressure, without loss of fluid or inclusion of air into the system.

Type 5100 coupling has a wide range of industrial uses on air, water, hydraulic, fuel and lube oil lines. It is ideal for stationary and mobile equipment where fluid-carrying lines must be disconnected and reconnected frequently for servicing, moving, or interchanging of parts and accessories.

CATALOG No. 200 contains complete information on Aeroquip Self-Sealing Couplings and flexible hose lines with reusable fittings, plus valuable fluid line data. Write for your copy.

Aeroquip

REG. TRADEMARK

AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

(A Subsidiary of Aeroquip Corporation)

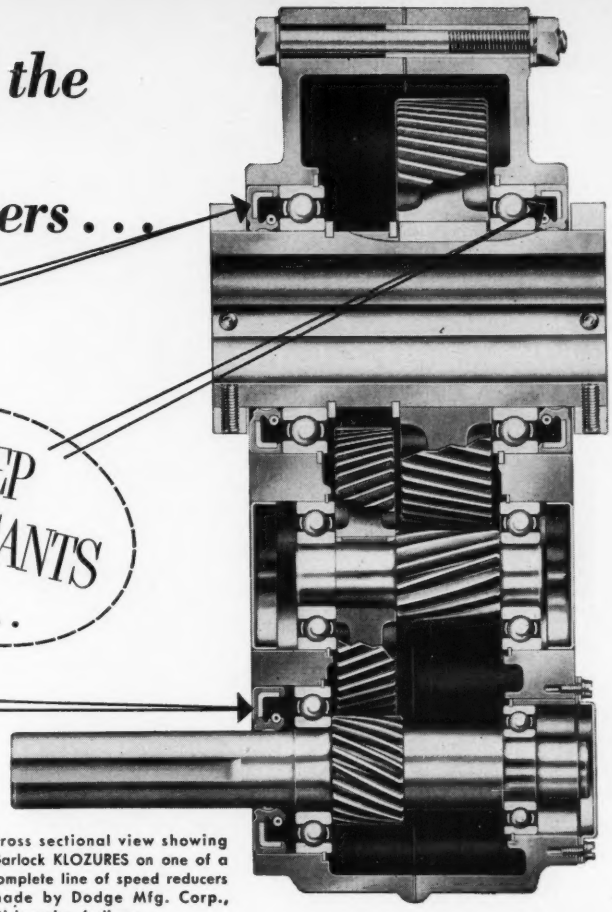
REPRESENTATIVES IN PRINCIPAL CITIES IN CANADA. AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. AND ABROAD

Over half the speed reducer manufacturers . . .

KEEP DIRT OUT . . .

KEEP LUBRICANTS IN . . .

WITH **KLOZURE*** **Oil Seals**



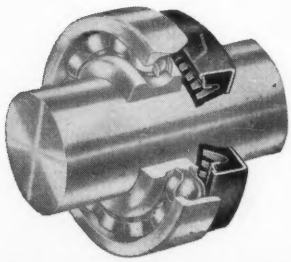
Cross sectional view showing Garlock KLOZURES on one of a complete line of speed reducers made by Dodge Mfg. Corp., Mishawaka, Indiana.

Makers of such fine precision products as The Dodge Torque-Arm Speed Reducer will not compromise when specifying oil seals. They know that the reputation of their entire product may depend on the quality of the oil seals they put in it.

Think about this the next time you have occasion to specify oil seals, and we think you'll choose Garlock KLOZURE Oil Seals—guaranteed to do the job you specify with minimum power loss and heat generation.

KLOZURES are available in a complete range of types and sizes. Therefore, be sure to call in one of Garlock's 125 trained sales engineers right at the start. His experience will save you time and money. Or, write today for Catalog No. 10.

**Registered Trademark*

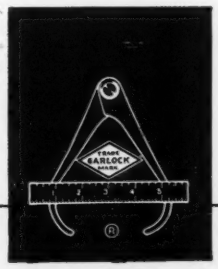


Model 53 finger spring KLOZURE for normal and high speed service, applied to a shaft to protect the ball bearing.

THE GARLOCK PACKING COMPANY OF CANADA LTD.

General Offices: Toronto, Ont.
Branch Offices: Hamilton, Montreal, Winnipeg, Calgary, Vancouver

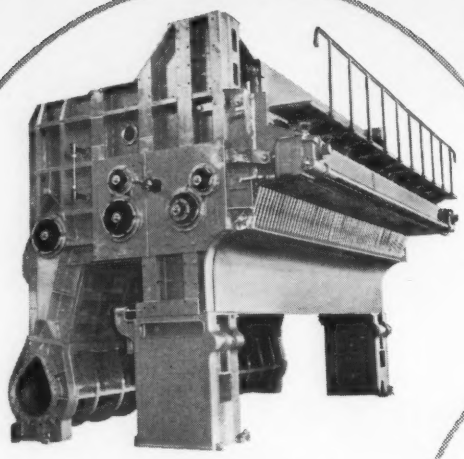
GARLOCK



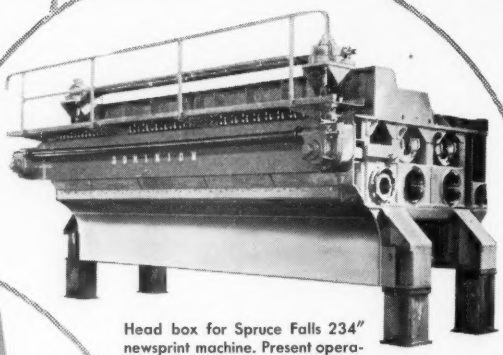
Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

"DOMINION"

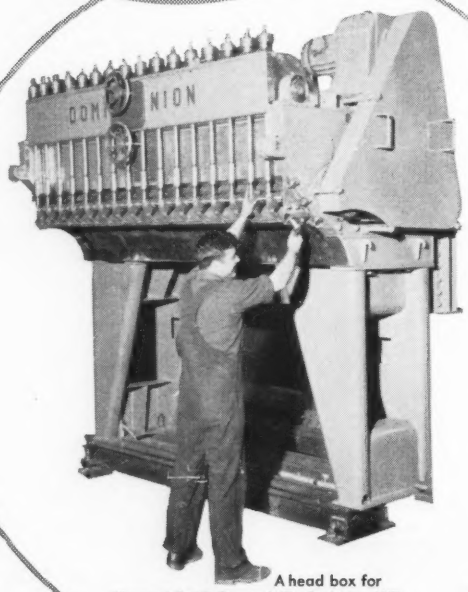
contributes to progressive improvements in Canadian paper making machinery



Dominion patented head box for Elk Falls 284" newsprint machine. Designed for operating speed of 2,000 F.P.M.



Head box for Spruce Falls 234" newsprint machine. Present operating speed: 1550 F.P.M. Increase to 2,000 F.P.M. planned.



A head box for Howard Smith Paper Mills Crabtree Mill 96" Yankee Tissue Machine, designed for 2,000 F.P.M.

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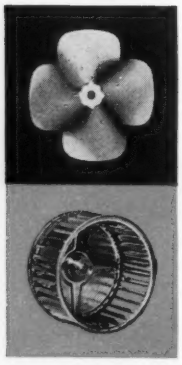

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People

U. S. institute votes Canuck best alumnus

Air-photo expert at PSC Worked on Lancaster set-up

ONE OF CANADA'S leading photographic experts, **Donald S. Ross** has been unanimously chosen the outstanding alumnus of the famed Rochester Institute of Technology for 1956.

A 1940 graduate in photographic technology, he will be given a presentation at the Rochester Alumni Association banquet at the Institute on May 19. He now heads photographic and optic projects at PSC Applied Research.

Photographic expert Ross had 15 years distinguished service with the photographic branch of the Royal Canadian Air Force where he was the senior officer. His most recent post was as a Wing Commander in charge of the RCAF Photographic Establishment at Ottawa.

When Applied Research Limited started after World War II, expert Ross worked in liaison throughout his RCAF command with the company which is preparing to survey Venezuela.

Much of the survey equipment for the photographic Lancaster aircraft which subsequently photographed much of Canada for mapping was developed under his direction.

Photographic assignments have taken the itinerant Ross throughout Europe and the Far East. He will be a Canadian reporter on photography and navigation to the Eighth International Congress of the International Society of Photogrammertry in Stockholm in July, 1956. And in Washington D.C. last month he demonstrated various mapping devices, including the Gamble Stereo Plotter at the combined meeting of the American Congress of Surveying and Mapping, and the American Society of Photogrammetry.

• • •

Shot shells tooled by father Becomes vice-president

"THERE IS DEFINITE evidence of the trend toward automation in firms which do engineering tooling," says **John D. Fraser,** vice-president of Peerless Engineering.

"In cases where we used to build a series of units to do a job, now we only supply one," he added.

The company, which was started by his father, D. M. Fraser and J. Martin in 1925, was bought out by D. M. Fraser five years later, who was president until his death a few years ago. Since then his wife has acted as president.

In effect, it was the mother who appointed her son as vice-president and at the same time made John R. Kirkpatrick assistant general manager in another executive move.

Both appointees served in World War II, Fraser with the Canadian and Royal Navy and Kirkpatrick with the U. S. Navy.

It was during the early war years

JOHN D. FRASER
Mother at the helm

that the company, which until then had only a few employees began to expand to today's staff of 75.

"We were making tools for the manufacture of guns and aircraft," he recalls, "and ironically I was soon to be in action using shells that had been in many cases tooled with machines from our own company."

Energetic Fraser who is an ardent golfer is a member of the Mississauga Golf Club and the Toronto Granite Club.

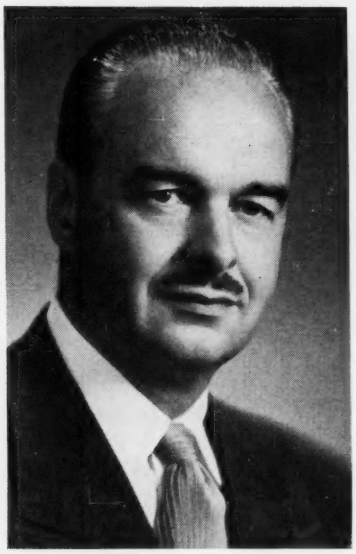
• • •

Admiral names executive Is licensed patent attorney

AN ELECTRICAL engineer, who is a registered Canadian patent attorney, is Canadian Admiral Corp. new executive vice-president.

Sports - loving 44-year-old **Stuart D. Brownlee** — head of the Canadian division of the company — was born in Ottawa and moved to Toronto in 1927. He attended Toronto University and graduated in engineering in 1933.

"I was three years in small appliance design with the Canadian General



STUART BROWNLEE
Patent expert to Admiral

Electric Co., before I decided to get into the patent field," Vice-President Brownlee told Design Engineering in a pre-flight interview before he took off for Chicago in the company's executive aircraft.

"Did you have to become a lawyer as well as an engineer?" the editor asked him.

Engineer Brownlee explained that he did not, although he can file and prosecute patent applications for registration of industrial designs. In his career in the patent field he was president of Canadian Radio Patents Ltd., a central electronic patent licensing agency for 10 years.

Former general manager of the Radio-Electronics-Television Manufacturers Association (RETMA), he has just become chairman of the organization's color TV committee, which was set up to study the future for color in Canada.

Inventive Brownlee holds patents on products ranging from a "swivel-tail" cord in socket to a combination coffee table, tea wagon and bar which he designed in his spare time.

When he is not busy professionally, he relaxes with his wife and two children. This takes the form of swimming in his own backyard 30 ft by 40 ft pool. A round of golf or a skiing party gives him a further opportunity to take it easy at his home situated near Toronto.

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***SAMPLES** of these Burndy Nyloclips will be sent you without cost upon your written request.*

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BURNDY

5602

Connecting pins of molded nylon conveyor belt break when belt jams, can be replaced in a moment.

Nylon Zytel—Why, where it is used

Searching for parts material that seldom needs lubrication, resists heat and abrasion? — Nylon is it! See it in gears, zippers, or toys

MENTION NYLON and you usually think of it as a glamorous textile fibre. But in the form of a plastic molding resin it has also become identified as an engineering material with wide uses.

Gears, bearings, cams, bushings and many other molded and extruded mechanical parts of nylon are now found in automobiles, aircraft, household appliances, electrical goods, business machines—dozens

Facts in brief about Nylon Zytel

Zytel nylon resin is being used mostly in mechanical parts—gears, bearings, cams, rollers, and similar items. For this kind of work it offers a number of unusual properties.

For example, in moving parts, it provides quiet operation, either with no lubrication, or with less than is required by other materials.

In many cases it has economic advantages over other materials because of its rapid, mass production molding; lightness of weight (more parts per pound); and superior performance.

Many materials can be made by injection molding, a rapid, continuous process in which Zytel is melted and forced under pressure into a mold. Many parts are made simultaneously. And in one case, 320 parts are molded in a single shot, in about one minute. The individual pieces are removed from the skeleton structure, or sprue, after which the sprue is granulated and passed through the machine gun.

Injection molding has the advantages of speedy production, and low mold cost per piece when large quantities are produced. There is little or no cost of finishing after molding.

Zytel is also extruded as strips, tubing, rods, jacketing over wire, and sheeting. Parts are frequently machined from molded or extruded rods and strip and some types applied from solution.

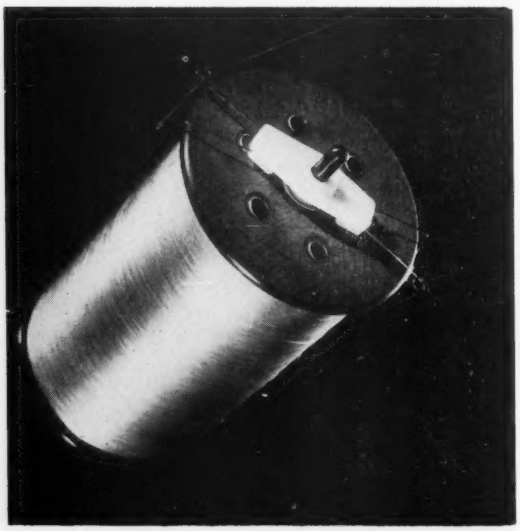
Nylon is light weight, withstands heat

Advantage of nylon plastic ware is ability to stand many daily sterilizings with no warping or cracks.

TABLE 1

Engineering properties of Zytel 101

Tensile Strength	(73 deg F)	10,500 psi
Elongation	(73 deg F)	90%
Impact strength Izod	73 deg F	1.0 ft lb/in.
Stiffness	73 deg F	200,000 psi
Rockwell hardness		R 118
Coefficient of linear expansion per deg F		5. $5x10^{-5}$
Heat distortion temp. (66 psi)		360 deg F



Flyer nylon block in textile machine travels 15,000 rpm, is one-piece molded to fit spindle, hold wire.

of industrial applications. It can be used to advantage in items from hypodermic needles, to combs, buttons, tumblers, zippers and toys.

With high tensile and impact strength it also has great heat and abrasion resistance. Nylon is light weight, has good dielectric properties and is unaffected by most chemicals. Mechanical parts made from it seldom require lubrication.

Nylon resin can be either injection molded or extruded. In any necessary after-molding operations it can be machined to close tolerances with standard equipment. It can be drilled, reamed, sawed, turned, threaded, blanked, punched, finished and cemented. Its machinability is comparable to brass.

As with all plastics, nylon reacts to the same physical laws and must obey the same established rules of design which govern other, more familiar materials, considering the need for good looks, sound economics, available manufacturing methods and an idea of what the product should do in its job. Likewise the sound design of nylon products calls for an understanding of the plastic's engineering qualities.

Nylon molding resins, supplied by Du Pont of Canada under the trade name "Zytel," come in a number of different grades, each with slightly different characteristics. Table 1 lists the important engineering properties of the most widely used grade, Zytel 101, as measured by ASTM tests.

What about the cost angle?

Naturally, the cost of nylon is an important consideration to the design engineer. On a per pound basis, nylon is usually more expensive than the common metals (a recent reduction set the price of "Zytel" 101 at $1.33 a pound).

However, the specific gravity of nylon is about 1.14 corresponding to a density of about 71 lb/cu ft. Taking the volume relationship between nylon and common metals into consideration, the material cost of a molded part is usually less with nylon. If it pays to use nylon, the designer is then interested in its properties as they will affect the finished article's performance. Here are some of the pertinent engineering facts.

The dynamic co-efficient of friction for nylon is somewhat difficult to express, and perhaps the best illustration lies in the material's behavior as a bearing. Its static coefficient against polished steel is 0.15, but nylon has a tendency to glaze over after an initial break-in run which results in a reduction of friction.

While this tough glazed surface is being produced, the nylon produces a high polish on the shaft, further reducing the friction and developing ideal conditions for long bearing life. Tests indicate that the minimum friction coefficient and ideal operating conditions are usually reached after about four hours of break-in running. After this, conditions stabilize for long service life. Largely because of its low coefficient of friction, nylon can often be used without lubrication. Where some lubrication is required, water, milk or detergents as well as conventional oils and greases may be used.

Nylon's tough, slightly yielding surface suffers little wear during prolonged service. It will absorb shock and together with its low coefficient of friction, it is prac-

and parts seldom need any lubrication

tically immune to frictional wear if its load-carrying capacity is not exceeded. Nylon bearings, for example, have outlasted metal bearings where both were operated in the presence of sand, since the abrasive particles imbed themselves in the nylon surface.

In standard Taber abrasion tests, Zytel 101 has lost only from one-half to one-tenth the material that a number of other commercial plastics lost under comparable conditions. Ball mill tumbling tests resulted in a weight loss of less than one-tenth that of hard rubber, cast aluminum or mild steel.

These experiments reveaied that moisture on the nylon surface improved abrasion resistance slightly, while it was lowered if the surface remained absolutely dry.

Nylon will shave fast

Where a cutting action takes place, nylon will shave away rapidly, since it machines easily. However, a sharp edge normal to the surface will make a mark but will not necessarily remove any material. For instance, nylon conveyor sections moving under stalled cans or glass bottles may mar, but will not show an appreciable loss of weight.

Nylon has the ability to deform slightly at points where stresses are concentrated, thus distributing the load over a larger area. It usually recovers its original shape when the load is removed, unless, of course, it has been unduly stressed. In nylon bearings as an example, this resiliency enables them to run quietly and efficiently with much larger clearances than is possible with metal bearings.

The metal bearing with large clearance will chatter and cause wear by inpingement. In another example, a one in metal bushing will often require a clearance of something like 0.003 for quiet operation while the same size nylon bushing in the same job will work quietly and without wear with a clearance of 0.006 in.

Impact toughness, or the ability to absorb impact energy, is difficult to predict in a molded part because the shape has the major effect on the way it works. Knowing how a part resists an impact, however, will help in selecting a good design.

The energy of an impact has to be absorbed by a force developed in the part multiplied by a distance that that part can deform. Building flexibility into the part so that the distance factor becomes larger, greatly reduces the force required to resist the impact.

Thin-walled flexible pieces like coil forms or the open end of tumblers for instance, are almost indestructible by impact. On the other hand, rigid corners supported in two or more directions, or thicker sections, may be less tough because they cannot safely deform.

Do nylon moldings keep their toughness indefinitely when there is no degradation such as sunlight, high temperatures and reactive chemicals? Some reports say that molded nylon parts became brittle after long storage under non-degrading conditions, but controlled tests have shown that, stored at ordinary room temperatures and humidities, Zytel moldings did not become less tough as measured by elongation and Izod impact.

Miscellaneous observations seem to back up these findings. For example, bars of nylon, which had been

Check these research facts

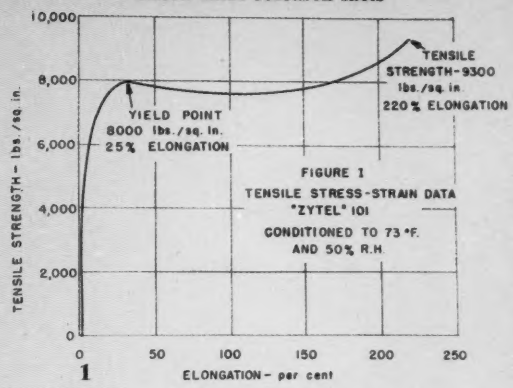


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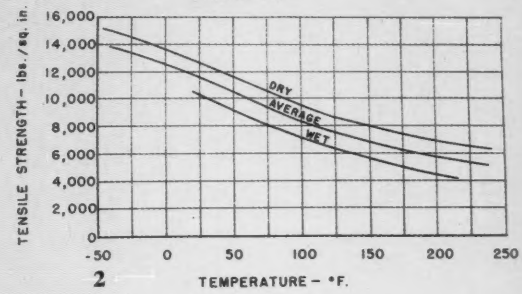
FIGURE II
TENSILE STRENGTH vs. ENVIRONMENT "ZYTEL" 101



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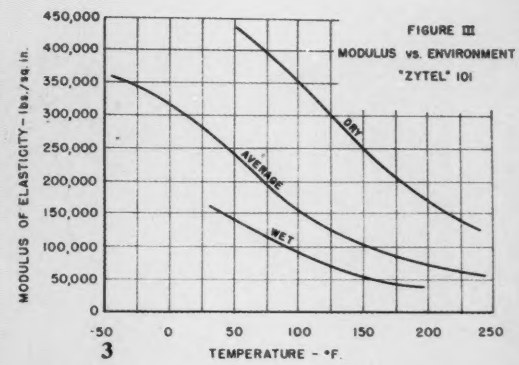

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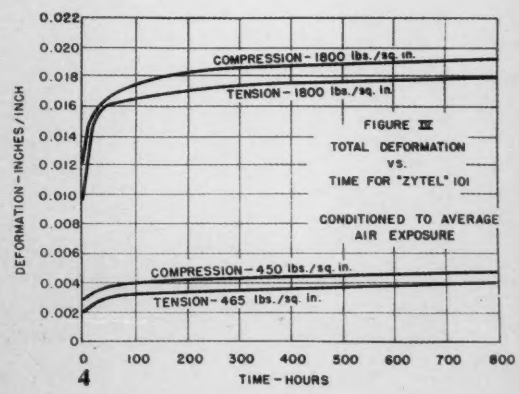

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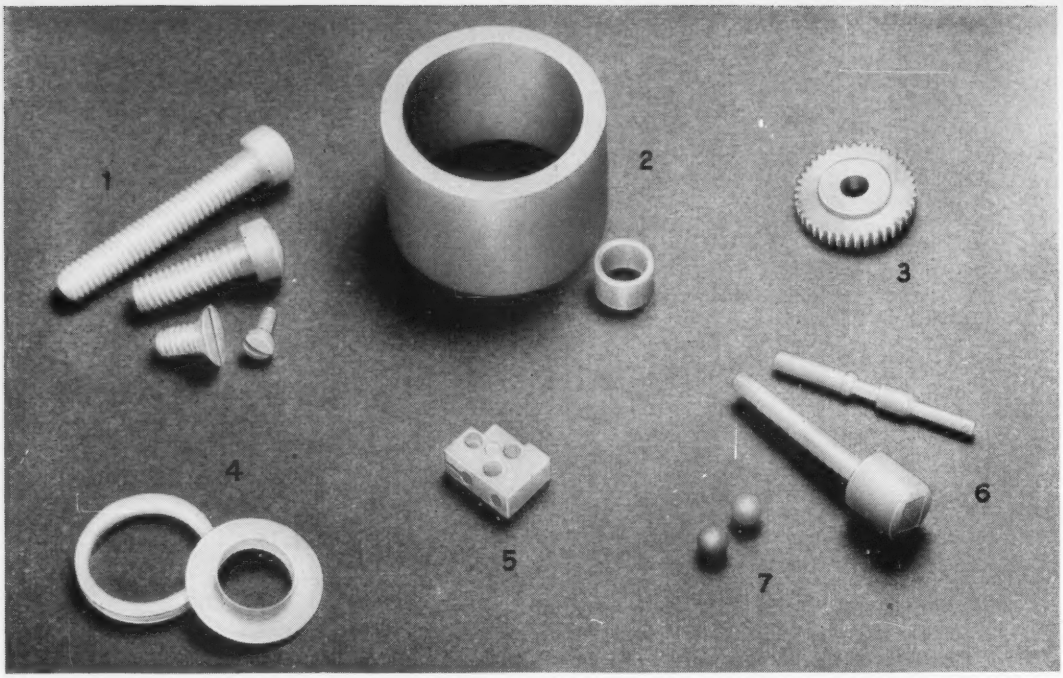
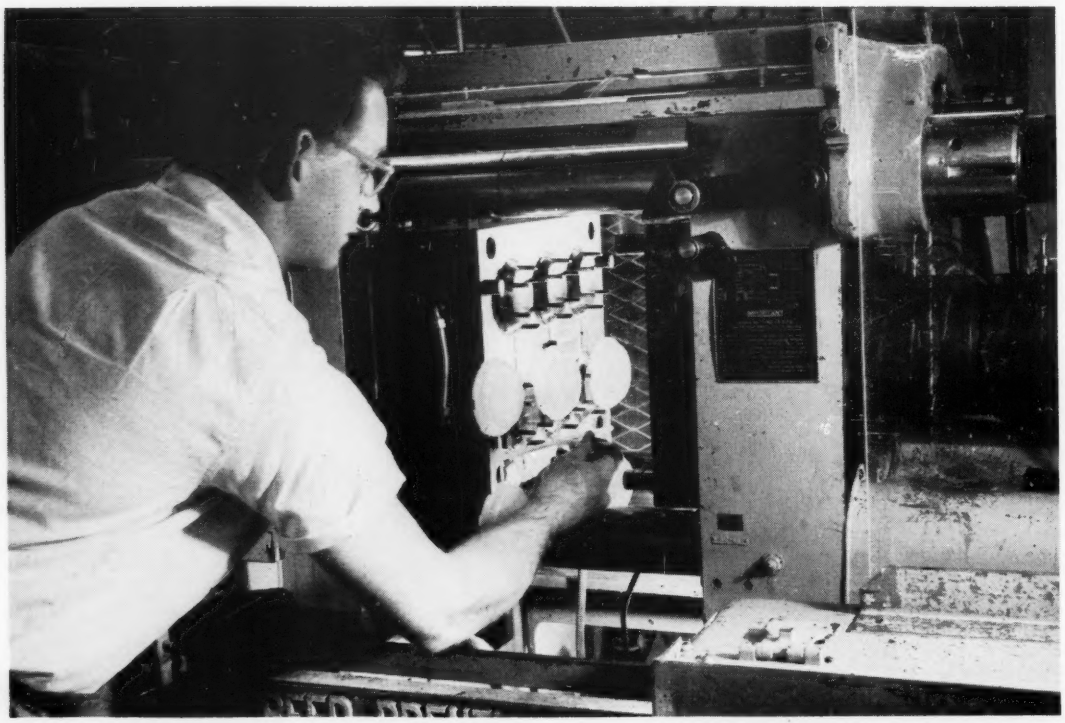


Canadian-machined from nylon forms are: (1) filister, flat-headed screws; (2) bushing; (3) timer gear; (4) gaskets, grommets; (5) coil form; (6) instrument shaft; (7) check-valve ball gates, shown as samples.

Sound nylon product design calls for know-how of its engineering qualities.



Mass production of precision made nylon products is possible by injection molding and standard equipment.

Nylon Zytel *(continued)*

stored for five years in an office desk exhibited the same Izod impact strength as would be expected of new bars.

Commonly used nylon resins have a relatively high upper temperature limit for intermittent exposure yet continuous long-time exposure to heat will result in oxidation and embrittlement of the outer surface in the presence of oxygen or air.

For longer service life where there are continuous high temperatures a heat-stabilized composition, Zytel 103, is recommended. It is estimated that this material will give over 100,000 hours of service at temperatures up to 200 deg F and something like 1,500 hours at 300 deg F. Its design properties remain the same as those for ordinary nylon, except for impact resistance which is cut by approximately one half.

A stress-strain curve is usually used to show the strength and deformity of a material, stress being measured in pounds per square inch and the unit deformation, or strain, in per cent or in inches. A typical stress-strain curve is shown (fig. 1) for Zytel 101. According to this graph, the yield point for this sample is shown as 8,000 psi at 25% elongation, with an ultimate tensile strength of 9,300 psi and an elongation of 220%. The test bar used in deriving these figures was fully moisture-conditioned. ASTM tests, however, do not call for full moisture-conditioning and therefore give the figures shown in Table 1.

TABLE 2

Dimensions (in.)	Tolerance — (in.)
Less than 0.5	±0.001
0.5 to 1.0	±0.002
Above 1.0	±0.002 +0.001 in. per in.

Stiffness of a material is most usefully measured by the modulus of elasticity. A high modulus means that the material will not deform readily under a given load. By definition, the modulus is the slope of the stress-strain curve shown (fig. 1) for Zytel 101. According a straight line. Obviously then, modulus values cannot be used to predict accurately deformation at stresses beyond the straight line portion of the curve.

Accurate design work with nylon requires a knowledge of how tensile strength and the modulus of elasticity vary with environment.

The properties of all materials, of course, vary with temperature. In addition nylon's properties are dependent to a large degree on moisture content.

Nylon is hydroscopic and will absorb moisture from its surroundings until, in time, an equilibrium is reached. This pick-up of moisture by a nylon part greatly improves its toughness and impact resistance, but reduces strength and stiffness.

Tensile strength (fig. 2) of Zytel 101 at various temperatures and moisture conditions is shown. Since strength is reduced at higher temperatures and moisture ranges, the working stress used in design work should be based on the tensile strength value for the most temperature and moisture normally looked for in the product life of items made of this material.

Similar data on the modulus of elasticity is shown in fig. 3. The importance of selecting the correct modulus is apparent from the magnitude of the change with environment.

One design factor which is less frequently encountered with metals than with plastics in continual deformation with time is normally called "creep" of "cold flow." Creep-time relations for nylon at various stress levels have been fairly well demonstrated by Marin (Proceedings of the ASTM, Vol. 54, 1954, page 1313).

This information for Zytel 101 for both tension and compression, shown in fig. 4, reveals the fact that any major deformation takes place within approximately 24 hours after molding. This is of particular value in setting up tests to check the performance of a specific part under load—the total deformation at the end of 24 hours will be about 75% of that obtained at the end of one year. The creep after one year is so small that for all practical purposes it can be ignored, and so short-term results.

In many uses, the dimensional stability of nylon is an important consideration. Where part must be assembled or used with other parts there is usually some range outside of which a critical dimension will not work well.

One of the major factors affecting dimensional control is absorbed moisture. Molded parts of Zytel have only a few tenths of one per cent moisture immediately after molding, but, as mentioned previously, the parts will absorb moisture from the surroundings until they reach equilibrium.

At 50% relative humidity, a molded nylon part will grow 0.008 in. per in. Moisture is absorbed on the surface and then spreads into the molding's centre. It is the diffusion rate that is very slow, so the thickness of a part has a big effect on the time required to reach equilibrium. The resulting dimensional changes due to moisture pick-up, unless allowed for in the design, may ultimately cause binding or other difficulties. However, once a molding is near equilibrium with the environment, intermittent changes in relative humidity will have little or no effect upon dimensions.

For moldings with critical dimensions, moisture conditioning to equilibrium with the expected environment is specified. Normally, moisture conditioning is done by immersing the object in boiling water.

The closer the tolerance, the more expensive the part is to manufacture. But in many instances, the close tolerances required of metal parts are not necessary with nylon.

In general, good molding practice can hold to the values in Table 2.

Uniform sections, particularly circular sections around a core, can be held to one half of these tolerances. Dimensions crossing a parting line should allow ±0.001 on the tolerances listed.

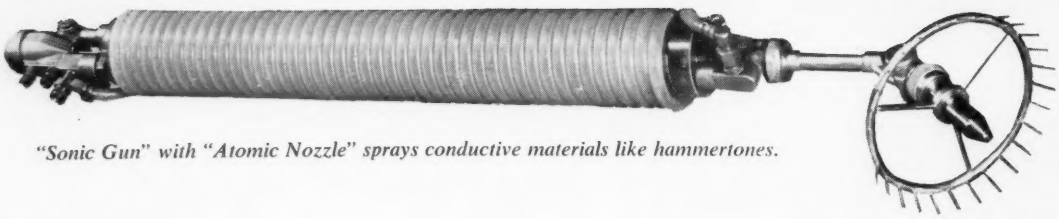
For best molding performance it is suggested that wall sections be kept as even as possible.

Thin sections should be gradually joined to thick sections; this also applies to ribs.

Radii should be used on all internal corners. These should be at least one fourth the wall thickness and never less than 1/32 inch. The larger the fillet the better.

Undercuts, particularly on internal surfaces, should be avoided where possible, since split molds increase the cost of the molding operation. It is usually more economical to machine such surfaces later.

Inserts of other material can be incorporated into a mold, but the molding *Continued on page 61*



"Sonic Gun" with "Atomic Nozzle" sprays conductive materials like hammertones.

Do you know the electrostatic spray?

A simple theory behind it — an enterprising future ahead for an old technique
Where there is a high production rate of similar-shaped objects it is ideal

By J. K. Whitely
CANADIAN INDUSTRIES LTD.

MANY NEW AND NOVEL ideas to the coatings industry came at the end of World War II. However, first five post-war years saw the development of these ideas without much trade acceptance. It was a period of discovery but not one of application. Many new raw materials were made available to the formulator, materials capable of producing properties in his products previously thought impossible.

The manufacturer by the same token was confronted with finishing methods which were designed to improve the quality of his saleable articles, and at the same time increase output.

One of these techniques which is gaining prominence and one that has proven extremely useful in recent years organic finishing is electro-static spraying.

The basic principle of electrostatic spraying is found in the simple rule that opposite electrical charges attract one another. By various means either the paint or the article to be coated is placed at a large potential difference to the other and the paint particles are then attracted to and deposited upon the work.

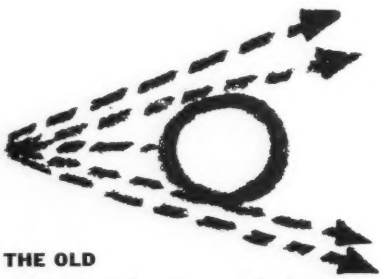
In normal spray finishing methods, the paint is thrown towards the article and a large amount passes by and is lost as overspray. However, when the paint is attracted, then a more efficient deposition takes place. By virtue of this attraction a phenomenon called "wrap-around" takes place. Wrap-around is the ability of particles to go around corners. Another advantage is reduced over-spray and improved over-spray absorption.

The first available electrostatic spray equipment involved giving the spray-gun one charge, and the work a charge of opposite polarity. Obviously this involved many problems of design, and improvements were soon forthcoming. The present applications involved either spraying through a charged grid or from an atomizing head which is held at high potential.

The equipment which is available at present would fall into four classes.

- Charged field with normal spray gun.
- Charged spray gun.
- Charged modified spray gun.
- Charged atomizing disc.

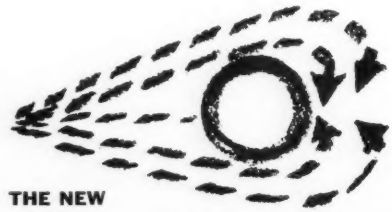
The first commercial installation used conventional spraying equipment and a normal conveyor line. The charge was imparted to the sprayed material by passing



THE OLD

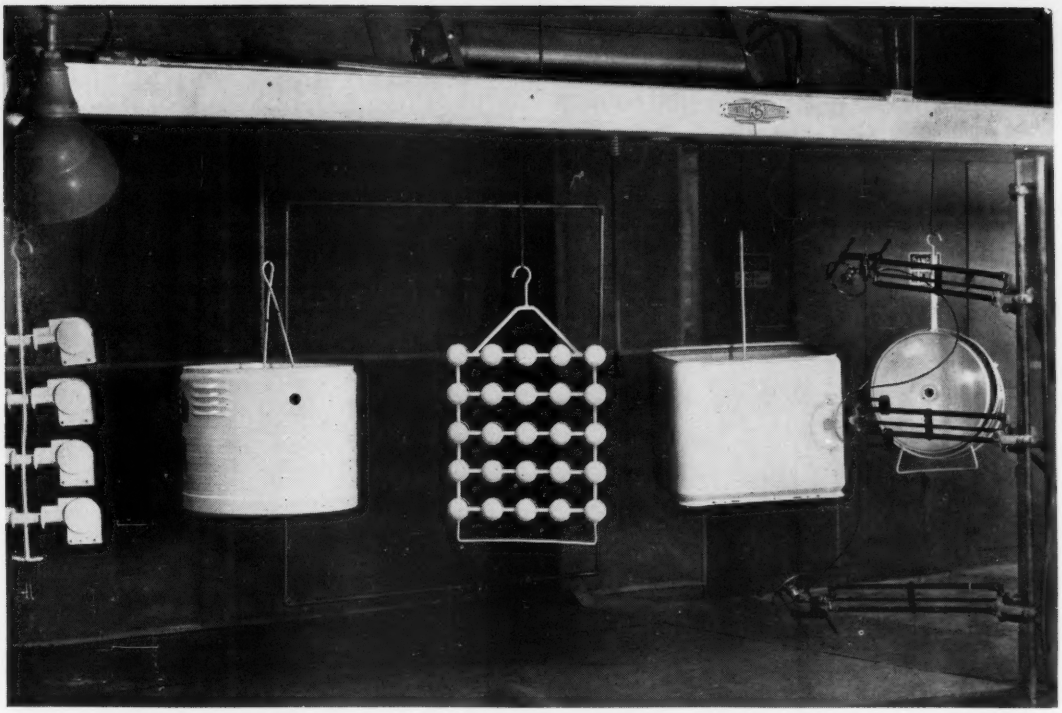
Using a regular spray method, paint veers from sides and fails to coat object's back.

It is an obvious improvement



THE NEW

Spraying electrostatically, the paint spreads on evenly on all surfaces as it wraps around.



Electrostatic spray units, right, coat products as they move along the conveyor line which is located above.

What savings will electrostatic spraying give?

- **Saving in paint.** Paint savings vary from job to job, depending on several factors that affect the relative efficiencies. The No. 2 Process will provide up to 5 times the paint mileage of **hand spray** and up to twice the mileage of **any other** spray system, including even Ransburg's No. 1 Process. Production results show appreciable savings over dip and flo-coat, too.

- **Saving in labor.** Only one operator is needed, and the automatic features of the Ransburg equipment require only a fraction of his time for control. It is not unusual to replace many hand spray men with one unit.

- **Savings in rejects.** Rejects and re-work drop to a negligible amount due to elimination of major variables common to air spray methods: such as, atomizing air pressure, fluid delivery rate, spray pattern size and shape, and overspray exhaust air currents. A high degree of uniformity of finish is ensured, and positive duplication of results is easily accomplished. It frees production painting from dependence upon the art and skill of the operator and hand spray man.

- **Saving in equipment.** All the paint sprayed is deposited, so there is no overspray paint to be exhausted. Substantial savings are realized by elimination of conventional booths. No water-washed walls or other costly equipment for collection or removal of wasted paint are necessary.

- **Saving in exhaust.** Ventilation of the painting area is required only for control of solvent vapor. Exhaust air is therefore much less than is needed by other spray systems, and building heat loss is correspondingly lower, too. In addition, lower exhaust velocity promotes cleanliness.

- **Saving in floor space.** Compactness of Ransburg's No. 2 Process equipment often results in an appreciable saving in floor space.

- **Saving in compressed air.** No compressed air is needed. No. 2 is an all-electric system, truly push-button painting.

- **Saving in maintenance.** Clean-up and maintenance labor is only a fraction of that required by other spray methods.

Electrostatic spraying *(continued)*

the atomized paint through a grid which was held at a potential difference in the neighborhood of 100,000 volts.

Slower evaporating solvents are used in paints designed for electrostatic use and any over-sprayed particles are more easily absorbed into the finish.

In general the paint is sprayed at a slight angle to the direction of motion of the conveyor line and a more efficient deposition of material results. The greatest saving with this process is through the design of the system and the automatic nature of the equipment rather than through the electrostatic attraction. Established installations can be adapted easily to this system without excessive installation expense.

A slight modification to the first methods which differed only in design involved placing the charge on the spraying head rather than between the spray gun and the conveyor. The operation is similar to the previous method and the effect of electrostatic attraction is more pronounced since the charge is given directly to the paint and does not rely on induction.

You can modify a normal gun

A normal spray gun can be modified using probes which makes it possible to shape the spray pattern. These probes are similar to lightning rods in that they drain the charge off more heavily in the direction of the probe. In this manner recessed areas and dry edges can be filled in without using more spray heads which, in turn, would use more material.

This is primarily a modification of the second, i.e. the charge is placed on the spray head and not between the spray gun and the conveyor line. With this type, the spray gun is held perpendicular to the travel of the line.

In order to gain the most advantage from electrostatic process, it is necessary to adapt the spraying apparatus radically. Two types are presently available, one with flat discs or atomizing bells and the other, having a unique type of spray head with discs.

The disc and bell units use centrifugal force to propel the paint. The paint is pumped by a metering device to the charged head which is rotating at high speed (900 to 3,600 rpm).

The paint is thrown off the disc in a cone and because the charge on all particles is of the same polarity, the cone will open out and blanket the article. The bells are best adapted for use on large objects on a straight conveyor line, while the discs work best on a U-shaped line which circles the spraying head.

The other type of spray head involves the use of a very low atomizing pressure. The paint is allowed to impinge upon a small flat disc from which it is atomized and propelled with very low forward velocity into the spraying area. By this means the loss of material caused by projection at high velocity past the work is noticeably reduced and application is almost wholly by electrostatic attraction.

The modification of spraying apparatus is not the only way in which the electrostatic charge may be used. Another process which is called electrostatic detearing may be used for finishing articles which lend themselves to dip operations. When an article has been dipped, the excess paint will accumulate in droplets or tears along the lower edge. By the application of an electrostatic shield these tears can be attracted away and an even coat without heavy edges will result. The operation must be conveyorized and the articles to be finished must be of the same general shape and size.

If this were not the case, then smaller pieces which are far away from the grid would not be deteared and pieces close to the grid might arc. Safety precautions can be built in, which will shut the equipment off when either the operator or an article to be finished comes too close to the detearing grid.

There are many choices which a designer can make in the types of apparatus on the market. It only remains for him to make his choice based upon his own needs.

Electrostatic spray methods are adaptable where there is a high production rate of similarly shaped objects. Because of the nature of the equipment and the hazards, it is necessary that a conveyorized finishing line be used.

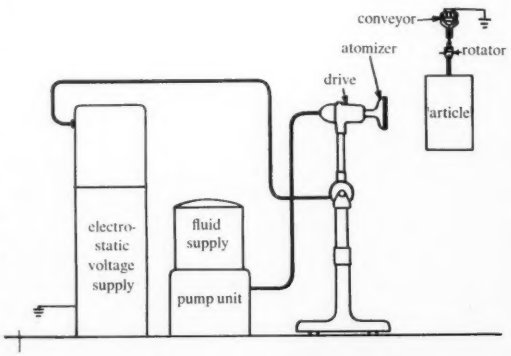
Fortunately, this process performs most successfully under automatic finishing conditions, so conveyorizing

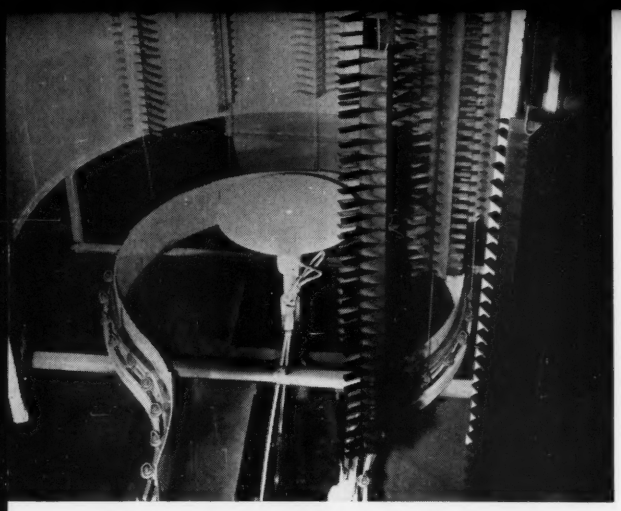
This is what you need to spray this way

The basic process is shown in the diagram (right). Articles to be painted are carried by a conveyor into the coating zone. They are grounded electrically by their hangers and may be rotated.

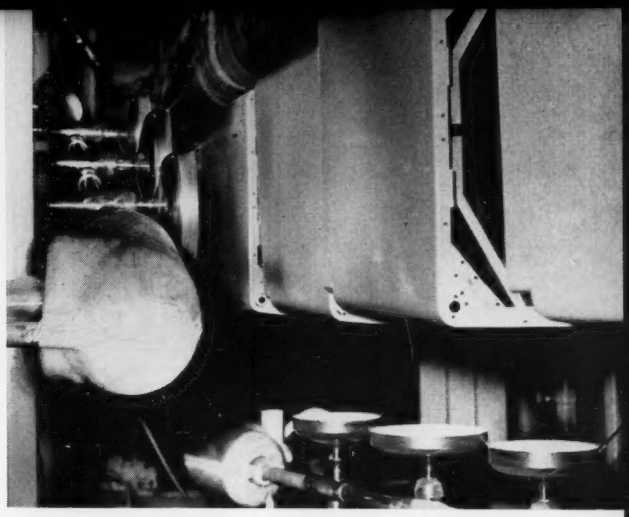
A voltage pack is connected to a paint sprayer, creating an electrostatic field between it and the moving articles.

A pump unit supplies paint through the hollow drive shaft of the atomizer, and rotation feeds the paint at a uniform rate through the atomizer to its outer edge. Atomization occurs under the influence of the electrostatic field, producing a spray pattern of electrically charged particles, while the irresistible attraction of the field pulls the spray to the articles.





Louvers are painted electrostatically as conveyor makes loop around No. 2 process reciprocating disc.



Similar-shaped parts move along conveyor belt as they are coated by spray units in mass production.

Schedule work so that many items of same color cut down the changeovers

is not a problem. This also avoids having personnel near to the unit while in operation.

If a large number of colors is to be employed, then electrostatic spraying methods are more difficult to apply since it is very difficult to make material changes in the line without a lengthy stopover. Work must be scheduled so that many units of the same color will come through one after another to minimize these changeovers. Modifications have been developed which will allow the use of two or three colors in one booth but this involves either the use of duplicate sets of equipment or a considerable loss of time for cleaning out the lines.

Here, one unit would be spraying while another was being cleaned for color changeover.

Most articles currently finished on production lines can be adapted to electrospray. Even non-conducting objects can be coated electrostatically. For detearing, the material does not matter and for spray, backing with a conductor provides sufficient attraction of the particles to return a good coating. Since electrostatic charge distributes evenly over a spherical surface, any obstructions or deviations from the circular nature of the object such as recesses or protruding edges, will give rise to uneven charge density and hence to uneven film thickness.

Changing the position of spray heads can reduce these tendencies but is it only by the use of probes that these drawbacks can be overcome. Probes are only of use where the articles are all of one shape, since the probes force the spray streams in a particular direction which would not necessarily be correct for other work.

If an object of very uneven shape such as lattice work or iron furniture is being coated, then the use of detearing apparatus would probably be more acceptable. Spraying methods could probably be used but the overspray losses would be very high and uneven film thickness caused by the shielding or recessed areas might result.

If it is likely that if products of widely differing size and shape are to be finished, then the simpler methods involving normal spraying heads would be most useful. By the design of special racks for the conveyor line, the bell or disc apparatus could be used but its full benefits would not be realized. Handled with care, this problem common to any automatic finishing drill, does not mean any serious limitations.

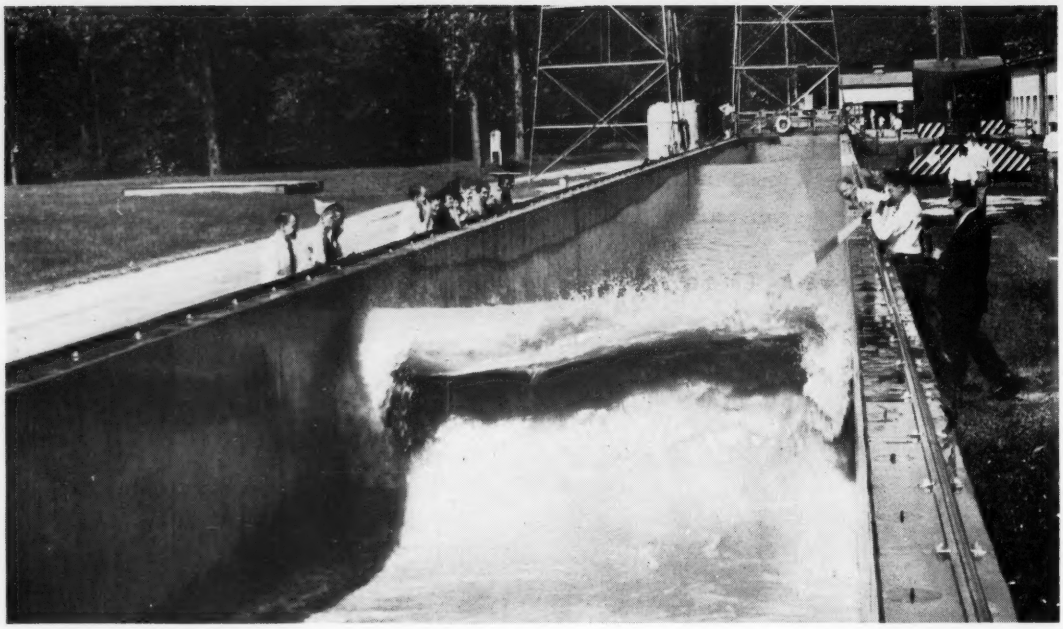
The danger of workers is not great if common sense is used. The main danger is the possibility of arcing between the high potential parts and ground, which could be caused by four things.

First, if the work comes too close to the spray through swinging or through poor conveyor design. Secondly, by bringing the spray heads too close to the charged grid (in earlier models). Third, a build up of paint on electrical equipment which could short circuit. And lastly, line surges in power input which could increase the distance through which a spark could jump.

In order to reduce these hazards the following points should be observed. All electrical equipment should be kept well outside the spraying area and high tension leads going to the apparatus should be rigidly supported and well insulated. All conveyor equipment should be carefully designed to avoid the possibility of the work coming within the critical arcing distance of the grids or spray head. The whole area should be adequately fenced and marked to prevent personnel from entering the spraying area when the equipment is in use. Where possible automatic controls would be preferable which would indicate the stoppage of ventilating fans or sudden surges in line voltage.

Electrostatic coating is a very useful and successful finishing method and is being widely used in industry. But as with most equipment, it has certain limitations. Since the operaton is automatic, regular maintenance of all working parts is necessary, and extreme care must be taken to guard against changes in any settings on the equipment.

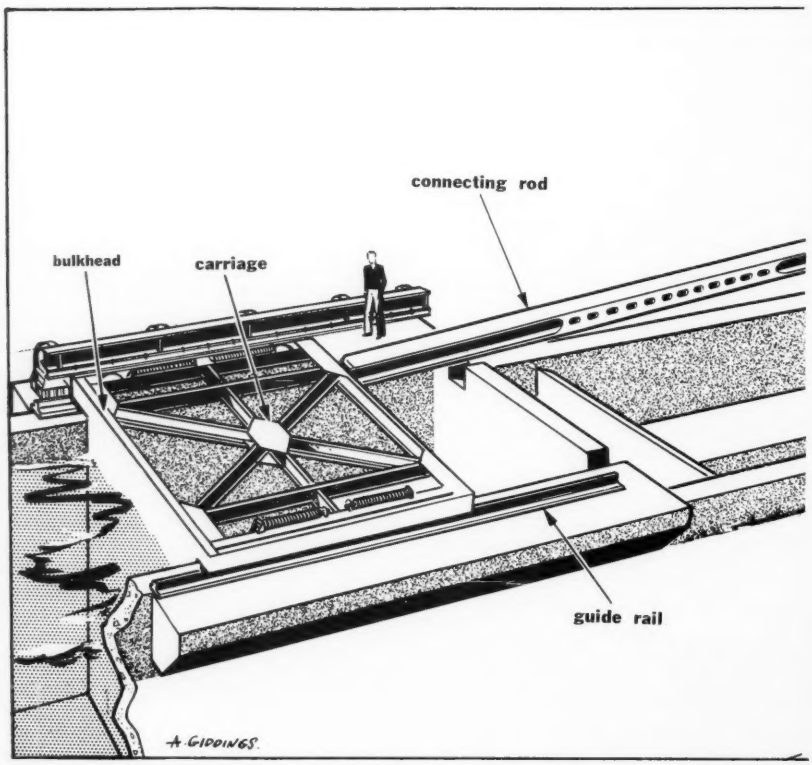
Flexibility in the operation of the finishing line is reduced since design is dependent upon the shape of the work and since color changeover is difficult. Despite these problems, the use of electrocoating methods is increasing and it could be one of the main application techniques used in the future, for appliance and small parts finishing. ★



Awed viewers watch 7 ft. waves sweep toward the shallow end, to topple and break just as nature arranges it.

You must make a wave to understand it

Each giant crank disc weighs 14 tons, has a diameter of 19 feet.



'The great strength of the machinery is a reminder that water in quantity

Big man-made waves were wanted for study. The U. S. army provided them — but found that artificial storms take some making

Alexander Barrie

MANAGING EDITOR

A HUGE, unbeautiful machine is going to teach U. S. army engineers how hurricane waves go about their costly attacks on coastal works.

Now, for the first time, big waves can be created at will and their force and effect studied. In what is officially named a "fact sheet" put out by the Washington Beach Erosion Board, it is claimed that this is going to add immeasurably to the fund of scientific knowledge on how to resist hurricanes.

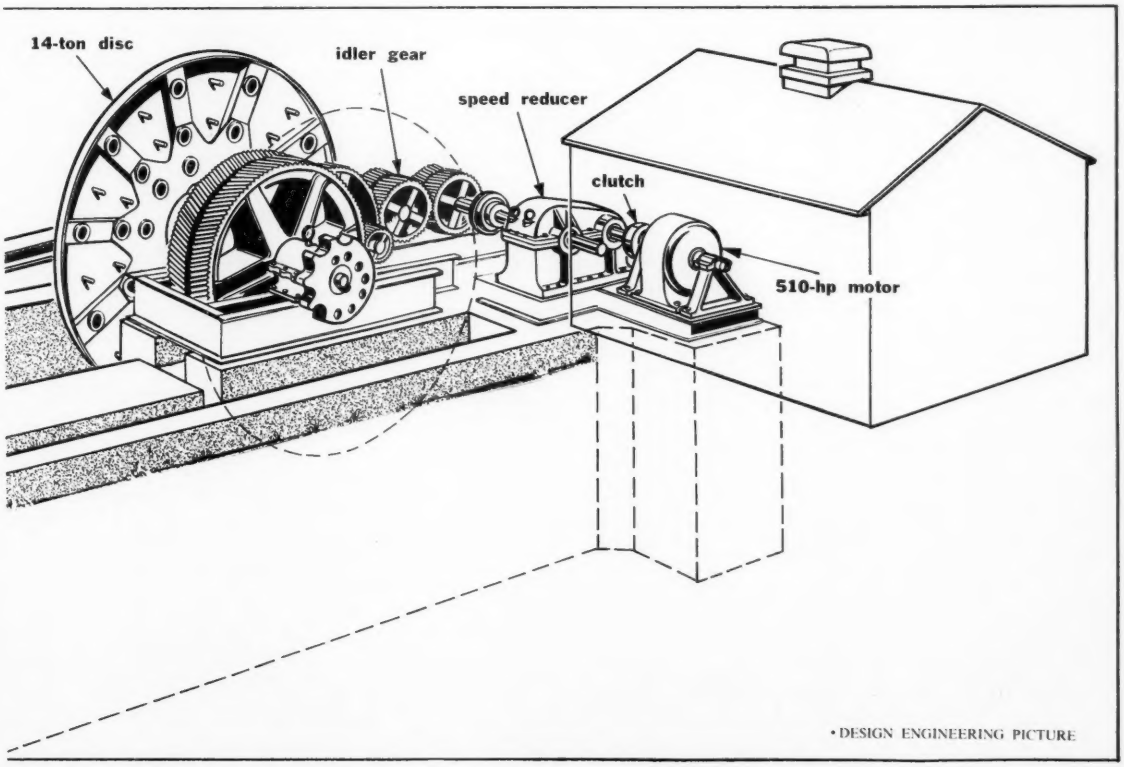
The idea behind the wave maker is very simple. A piston-like bulkhead is pushed forward and backward at the end of a very long tank filled with water. The size and frequency of the waves can be varied by changing the stroke and speed of the bulkhead's movement. The bottom of the tank has an upward graded slope which the waves sweep over and finally break onto — exactly as nature arranges it. And there it is.

Yet building this machine has been a sizeable engineering project. It ran up a bill of $700,000 and quite apart from design and manufacturing time, took six months just to install the machinery. Everything about it is big. The tank capacity is close to 200,000 cu. ft. and the wave-punching bulkhead (which forms the deep end of the tank) measures 15 ft. across by 22 ft. high.

Seven feet high waves can be built up by the machine; these are, by far, the biggest waves ever created by man. Wave makers of the past, installed in laboratories and swimming pools, have never been able to push them higher than about 2 ft.

Although it has just been completed, work on the project began seven years ago. In 1949, Congress instructed the Chief of Engineers to find out more about hurricane damage so that effective steps could be taken to prevent it. Construction of a super testing tank was then decided upon and authorized.

Within a year, careful studies were made which settled the size and working characteristics the tank should have; and building began. It stopped sooner than anyone expected in 1950 when the Korean war made other, more pressing, demands of army engineers. The tank had been completed but that was all. The machinery was unbuilt and very largely unthought about.



takes a great deal of moving.' With strength goes size—as the man studying the carriage shows.

Wave maker *(continued)*

Not until the fall of 1953 was there time or opportunity to go on with the project. Then, the Marine Design Division of the Corps of Engineers (Philadelphia District) started to design the working parts. They wasted little time. In six months the job had been done and approved and specialist manufacturers put to work on the heavy-weight components.

Pictures on these pages show how the tester works. An electric motor provides the power. It is hooked to a twin disc clutch, speed reducer and complex train of huge and heavy gears. The last of these gears sits between and aligned with two giant driving discs — all of which turn together, linked by a spindle.

The driving discs act much as the driving wheels on a steam locomotive in that each carries a connecting rod as a means of passing power further down the line. But in this case the rods are attached to a trolley which moves back and forth as the discs rotate. Suspended and braced from the trolley is the piston-type bulkhead. It surges forward delivering up to 35 tons of thrust to send a wall of water bounding away as an entirely real wave. Then, as the discs continue to rotate, it completes the cycle by withdrawing, ready for the next push.

It is the size of the component parts which is perhaps most surprising. The great strength of the machinery is a reminder that water in quantity takes a great deal of moving.

The motor is a 510 hp, 1,200 rpm Westinghouse type rated at 2,300 volts which came from surplus equipment already held by the Corps of Engineers. It is mounted under cover behind and to the side of the tank.

Its power passes through the clutch to herringbone type reduction gears in the speed reducer. Here the 1,200 rpm of the motor is slowed to 122 — a reduction ratio of 9.842 to 1.

The drive passes now through a steelflex coupling to the pinion gear which begins the long gear chain. From here on, right through to the bulkhead, everything is jumbo sized.

A special design difficulty came up with the pinion and its heavy neighbor, an idler gear. For despite their weight and bulk these had to be removable to give speed variations up front at the driving discs. This explains the presence of the steelflex coupling. It allows quick disconnection of the pinion drive shaft so that the pinion and idler can be changed to give different ratios. There are four alternative sets in use so far. They give speed reductions of 5.38, 3.80, 2.64 and 1.88. In this way the frequency of the waves can be controlled.

The pinion and idler gears drive an intermediate gear linked by a spindle to another smaller gear alongside. This is the intermediate pinion gear. Now the power is reaching the end of its long journey to the business end of the assembly.

The intermediate pinion gear turns the huge 121 herringbone tooth, 10 ft. diameter, 2 ft. wide main driving gear.

The driving gear is centred on the long axis of the test tank. A spindle runs through its hub to support the two immense welded steel discs — which show so clearly in the pictures.

These crank discs carry the extremely long connecting rods which move the trolley fore and aft. The arms are 18 in. by 11¾ in. beams running 43 ft. 9 in. in length. They are fitted with sleeve type bearings at each end. The driving end of each arm is connected to its crank disc by a 7½ in. diameter tapered pin fastened with a 4 in. standard nut.

Already speed variations have been allowed for by the use of alternative pinion and idler gears. But more than this is necessary. The stroke, too, must be variable. For this reason the connecting rods can be attached to the driving discs in different positions to give differing eccentricity.

The range of stroke length runs from 2 ft. to 17 ft. 6 in. The settings vary in half-inch increments from 1 ft. to 4 ft. and then in 3 in. increments from 4 ft. to 8 ft. 9 in. Eccentricity is, of course, half the stroke.

Counterbalancing has been allowed for. When the shortest stroke is in use the balance weight needed is 378 lb. For the longest stroke the poundage steps up to 3,820 — over 1½ tons.

Another design problem which had to be faced was the tendency for the connecting rod to push the back end of the trolley upward when it came forward and the front end upward when it pulled back. Some sort of anti-lifting device had to be included.

The method chosen was to equip the trolley with an extra pair of wheels at each end. These are inboard wheels which bear on an upper suspended rail. They are spring loaded to make sure that the trolley is firmly pressed downward at all times onto the lower rails.

The bulkhead hangs from the trolley, braced by struts at its quarter and three-quarter points.

The program ahead spans 20 years

The new machine has a busy time ahead of it. The Beach Erosion Board has forecast how long it will take to do all the experimental work already waiting to be done. The estimate quotes the astonishing time of 20 years. This is without adding a single project.

Careful thought is to go into priorities. The present programs cover wave effects on piles and beach slopes but the board has decided that priorities are going to have to be adjustable to meet the most critical needs.

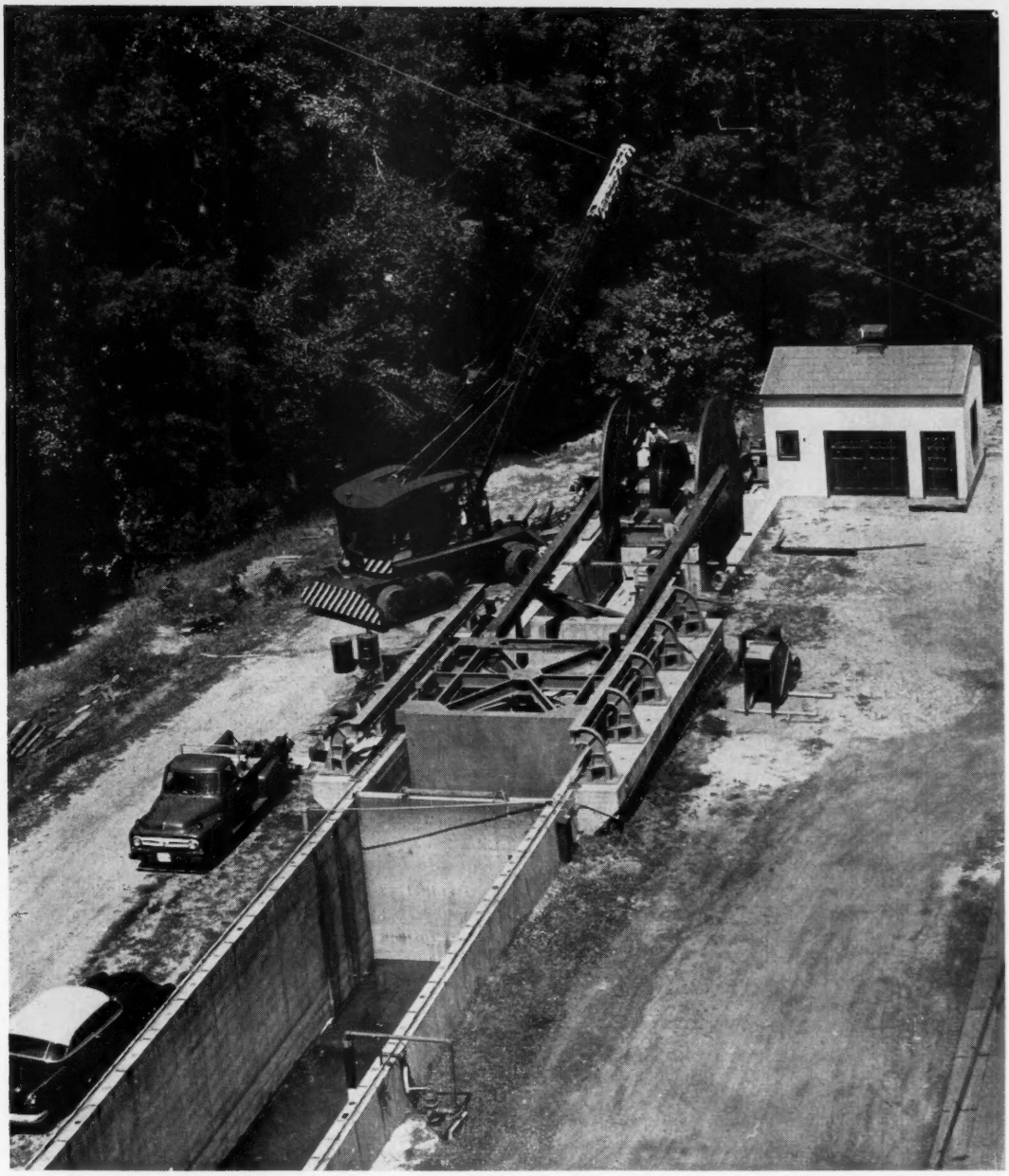
One obvious and important use of the new wave maker will be to help designers of landing craft, caissons, artificial harbors and sea dromes with carefully controlled test data. Earlier small-time wave testers have already been used for this purpose. Now much better, more revealing tests will become possible.

Besides defense uses there is a huge line up of civil experiments waiting too. On the revetment of a dam face, for example, immense savings may become possible when materials have been tested with scientific care and their best qualities made known.

Then there is the age old anxiety of shore erosion. The bottom of the test tank is covered with 1,100 cu. yards of sand which was graded to about a 1 in 15 slope. Here is a natural type beach which the waves will re-grade for scientists to watch. Much will be learned about erosion in the process.

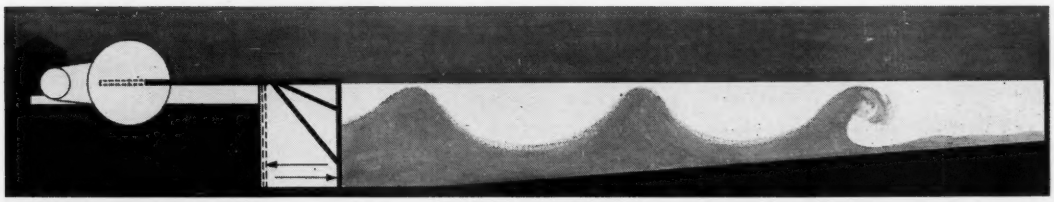
And what pressures do hurricane waves build up against bulkheads, sea walls, and banks? What is the effect of these pressures on stone, concrete, asphalt and other materials? And what about over-topping on nature's slopes and man made structures? In time, with the help of the new monster wave tester, science will know the answers for the first time.

The Corps of Engineers is contributing knowledge which will be put to use by generations of engineers. At $700,000 the cost has not been high. ★



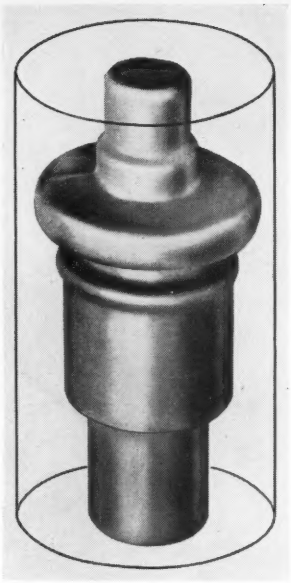
From the rear: Powerhouse, crank discs, trolley, bulkhead and deep end of the 700 ft. long wave-bearing tank.

As the biggest ever man-made waves sweep down the tank, science learns



How does it work? This sketch section shows. The plant (on left) drives a trolley from which a braced bulkhead is hung in the water tank. Movement is forward and back. Rhythm, speed vary to make waves of any size.

Shop method



Picture 1. Sprocket shaft closed die forged uses little more material, was formerly machined from bar stock.

Closed die forgings cut cost, inspection

A saving in metal — few design limitations make "as-forgings" popular

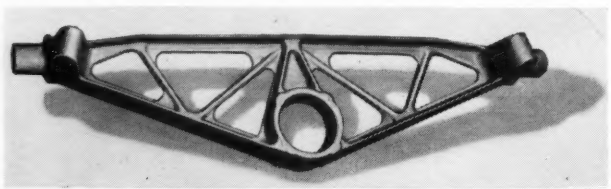
Forgings are being made ranging from less than an ounce up to tons

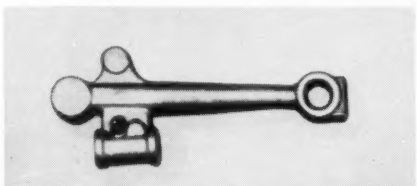
By WALDEMAR NAUJOKS

DROP FORGINGS ASSOCIATION

THERE ARE FEW PROCESSES for fabricating parts which offer as many opportunities to reduce cost of machine-finishing as closed die forging. Because such parts can be made within close tolerances of final shape and size, it is possible not only to save machining time, but metal as well. Note, in fig. 1, how forging saved 2.6 lb of metal per piece, or approximately 57%) in the production of the gear sprocket shaft; an extreme case, but indicative of the savings that may be achieved.

Forgings are frequently used "as-forged" where close fit or machined surfaces are not required. Cost and inspection can often be reduced because of the uniformly dependable quality of forgings. Excellent response of forgings to heat treatment also eliminates loss or rejection of parts that must be heat treated. In many cases, the extra margin of strength and wear resistance provided in forgings eliminates the need for heat treatment. Designers face few serious limitations on part shape, and virtually no limitation on size or weight when planning a part to be made by closed die forging. Forgings are currently being produced in weights ranging from less than one ounce up to several tons (fig. 2). Limitation on shape at the forging stage include such obvious items as the avoidance of holes with larger diameter at bottom than at top, angled pockets or excessive thin sections, to mention a few points.





Pic. 2. Aircraft fulcrum, left, is extremely light but the knuckle support at the right weighs several tons.

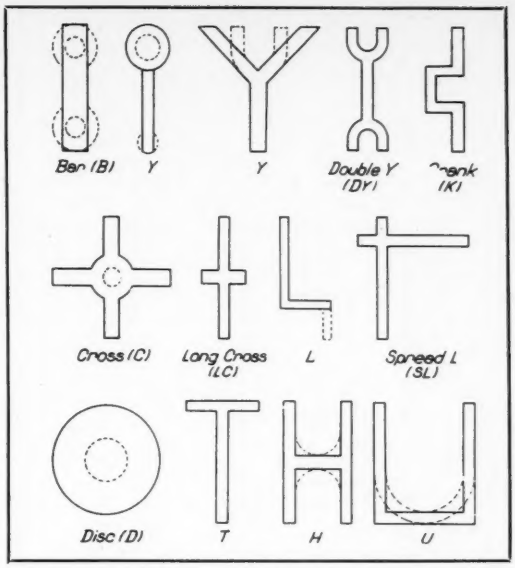
However, the advantages and economy achieved by forging often make it entirely practical to complete secondary details after forging. A group of common forging shapes are shown (fig. 3).

Materials from which forgings can be made include carbon steels, constructional alloy steels (manganese, nickel, nickel-chromium, molybdenum, chromium, vanadium, chromium-vanadium, tungsten, silicon-manganese), superalloys, corrosion and heat-resisting steels such as stainless steel, iron, copper, brass, bronze, nickel and nickel-copper alloys and light alloys such as titanium, aluminum and magnesium.

Parts which, because of extreme irregularity of shape, extreme length or other reasons, appear to be "unforgeable" often can be forged. The solution is to divide the part design into separate, forgeable components, which after forging, can be joined by welding. An example of this kind of "designed weldment" is shown (fig. 4).

Where a part shape contains a deep undercut, forging may still be found practical if production is planned so that the part is forged in an "L" or straight shape and then bent to the required "U" shape after forging.

Another approach is to bend a part **before** final forging. A round alloy steel bar is "gathered" (increased in section at points where more metal is needed) in an upset forging machine. Ends are tapered in forging rolls and the blank is then bent to the required shape in a bulldozer. Forging, trimming and punching complete the operation.



Pic. 3. Group of common forging shapes are shown. The forgings can be made from such a range of metals as carbon steels, iron, brass, stainless steel, nickel.

Pierced holes without machining

Deep impressions with 0 deg. draught, or completely pierced holes, can often be formed in forgings without machining or drilling. A forging machine, or upsetter, is employed for this purpose, following the closed die forging operation. Re-evaluation of complicated design, with attention to the strength and quality gained by forging, will often prove that the part can be made less complicated, and yet actually be improved, both in function and durability.

The fact that forged parts can be produced so as to be ready or nearly ready for use when received provides immediate evidence of the material savings possible. Note, again, the gear sprocket shaft. Important, too, is the wide margin of strength that forged parts offer over identical parts made by other processes. This margin usually makes it possible to eliminate dead weight or to simplify the part, and, in some cases, even to reduce part size. More efficient design, based on the extra strength of forgings is sure to bring savings in materials and finishing costs as shown in fig. 5.

Kneading and working action of the forging unit on metal eliminates the types of internal flaws that most often cause metal parts to be rejected in later processing —preventing the loss of both time and material.

Soundness and uniformity of forged metal assures uniform, easily controlled results in heat treating, and full quota of completed parts.

Basically, the surface of a forged part is a smooth surface. A minor amount of graininess is evident. However, this is generally not considered unattractive or objectionable, even where the part is to be used "as-forged" (cleaned, but not machined or ground).

There is no absolute requirement that forgings be machined or ground except where a "finished" surface or precision fit with other components is necessary. Where an improved surface is desired, a "coining" or "restriking" forging step often follows the actual shaping of the part. Tumbling and shot-blasting are also employed, both imparting some additional hardness to the surface.

Forging hammer or press pressure penetrates and thoroughly works the entire mass of a correctly designed forging—thus even where some metal must be removed, the resulting surface will be found uniformly dense and sound. Highest quality surfaces, such as required for plating are easily achieved. Parts used "as-forged" are often painted, the slight "tooth" of the forged surface assuring good adherence of the paint. A variety of surface finishes (figs. 6, 7, 8) are shown on parts of totally different design.

In determining where or how a forging might be better than other kinds of parts, planning can and probably should start with the same steps followed in planning any new part. These are a review of functional requirements, stresses of the required service, choice of

Pic. 4. Part design can be divided into separate forgeable components when it appears to be unforgeable as in the case of the designed weldment (pictured above).

material, and estimation of the processing steps required for completion of the part. There is a special advantage in considering conversion to forging in the fact that there is an actual part and production history available for comparison.

Better usage of materials through elimination of waste might be one incentive to consideration of forgings. Opportunity to improve the dependability of a part might be another. Excessive rejection of parts because of discovery of defects during processing could certainly be considered sufficient reason for considering forgings.

Generally, parts are specified as forgings for one or more of these reasons: to obtain a stronger part; to eliminate dead weight, waste or loss; or to simplify production.

If forging the part under consideration appears to answer such problems, consultation with a forging supplier should take place before a decision is made and before a design is approved. The experience and technical knowledge of the forging supplier's engineers can greatly supplement information developed up to this stage and may lead to further important economies or improvements.

The shape, size, and weight of a closed die forging may be determined much in the same way that any tool or mechanical part is planned. But, in the planning of a forged part, the designer begins with the advantage of hot working metal, and by control of grain structure and grain flow lines with closed forging dies. It is possible to increase part strength as much as 100% in this way.

Savings in material are almost certain to result because dimensional tolerances of the part can be held within close limits, and the part brought to nearly finished shape in one process.

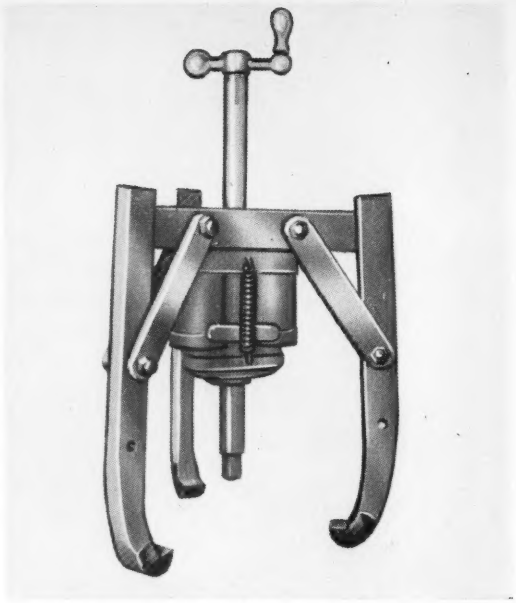
The shape of the part to be forged obviously determines the number of forging operations that will be necessary and the amount of metal to be used, beyond that required for the part itself. Choice between completing the part at the forging stage, or by subsequent machining, hinges on several factors, such as quantity, number of forging or machining steps, scrap loss, etc.

In some cases, a little additional machining will be found more economical—in other instances, forging the part complete will prove to be sound economy. Each part to be forged must be considered individually, in full relationship to every factor affecting its cost at point of final assembly.

The basis of strength and toughness in forgings is the controlled directioning of the grain flow lines or fibre-like structure present in forging quality metal. Correct design and correct forging technique position and form the metal in the forging dies so as to utilize these flow lines for maximum strength at points where it is most needed.

Just as wood is strongest in the direction of its fibre structure, the greatest strength of forged metal is parallel with its flow lines. A forging engineer's advice can be of material assistance in determining grain flow requirements to meet specific service conditions.

A twelve-page booklet, "Standard Practices and Tolerances for Impression Die Forgings," available from the Drop Forging Association, 419 South Walnut St., Lansing 33, Mich., gives standard tolerances for closed die forgings, classifying tolerances according to dimensions, draft angles, quantity, and fillet or corner radii.

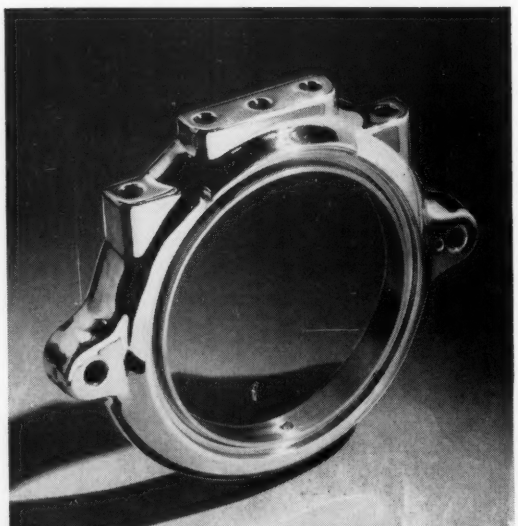


Finishing costs were 15% less, material losses 20% less in gear puller re-design for greater strength which was needed for stronger arms and crossheads.

General considerations which apply in the design of any forged part are as follows:

- Drop forging shapes are usually based on geometric figures, such as spheres, cylinders, cubes, prisms,

Shape determines forging operations



Pic. 6. High quality surfaces such as those required for plating are easily achieved as in the part shown above.

polyhedrons, cones, etc. Regular or symmetrical shapes are easier and less costly to produce

- Draught is usually necessary to prevent the forging from sticking in the dies. To determine the amount of draught needed, and its location on the piece, a parting line (point at which the dies meet) must be selected. Draught always originates at the parting line, but must be measured from the direction of the forging hammer stroke. The amount necessary for draught may be added to or subtracted from part dimensions.
- Sharp corners have a tendency to cause cracks to develop, both in dies and parts, and should be avoided. Parts with blind or pierced holes and depressions can be forged—however, where extra-deep, it is advisable to plan the part in consultation with the forging supplier. Bosses and stems are usually considered as projections on the main body of the forging—and may project vertically into the die cavity or occur in a horizontal position, parallel to the parting line.
- Drawings should be full size. Make separate drawings of the part "as-forged" and "completed." Show dotted lines on "completed" view for machining where necessary. Use arrows to indicate desired direction of grain flow. Cross-section drawings aid visualization —use freely. Projected views should show the intersecting lines of the part surfaces. Part numbers should be located on surfaces parallel to forging plane and are less costly if planned as raised numbers.

The soundness of the surface and internal metal of a part is vital to the manufacturer and the user of the completed equipment, and to everyone who may be affected in any way by the operation of the part and equipment.

The key factor is metal quality, and closed die forgings represent metal improved to its maximum degree of quality.

Special control is exercised in making forging quality metal of any type or grade, to ensure uniform quality. Hot rolling the billets of forging quality metal causes many variations in the structure of the ingot to be assimilated. At the same time, hot rolling develops a directional, fibre-like flow of grain structure. Stock for forging is cut from these billets with great care, according to the direction of grain flow. Equal care is given to positioning the stock in the forging dies, to assure that the grain flow rests so as to be most easily directioned by the impact and pressure of the forging hammer. The result is a dense, tough, strong part with remarkably uniform grain structure. The strengthening fibre-like grain flow lines follow part contours in layer upon layer, from centre to surface—unbroken at any point—providing a structure with maximum resistance to impact, shock, vibration and stress.

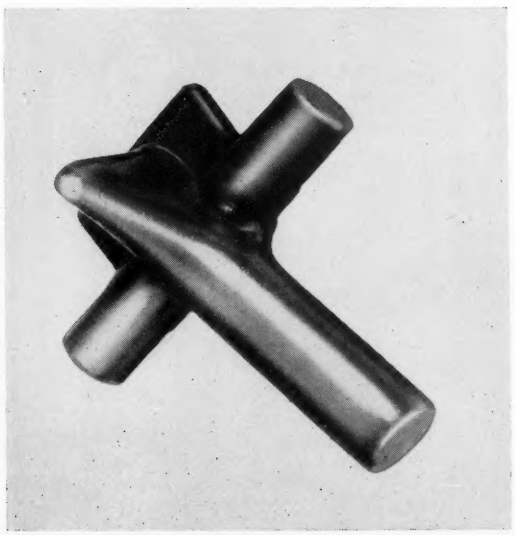
Laboratory-conducted fatigue tests of forged parts, in comparison with identical parts made by a commonly used alternate method, show that the forged product offers at least 50% greater fatigue strength, plus higher dependable tensile strength.

Forged parts may be heat treated for wear resistance beyond their normal high rating, with completely satisfactory results. Uniformity and density of grain structure obviously are the important factors, assuring even heating and cooling, and avoiding stress.

The way a part is made determines the level of performance to be expected from the material used. Every material offers certain properties—tensile strength, hardness, ductility, etc.—but, regardless of the part or design, virtually no material offers an ideal level or combination of qualities. Qualities must be brought into desired balance, by artificially "beefing up" part size or shape to simulate the qualities needed, or through actually upgrading properties by processing.

No other method of working metal approaches the ideal combination of physical properties in metal so exactly as closed die forgings, or provides greater opportunity to control specific properties, as closed die forgings. ★

and amount of metal to be used beyond amount required for the part



Pic. 7. Slight tooth of the forged surface assures a good adherence of the paint in many applications.

Pic. 8. This is another example of the many surface finishes that can be produced by closed die process.

Special 24 in. O.D. grinder polishes finish to 1 micro in., straight to 5 micro in., round to 10 micro in.

precision grinding—how far can it go?

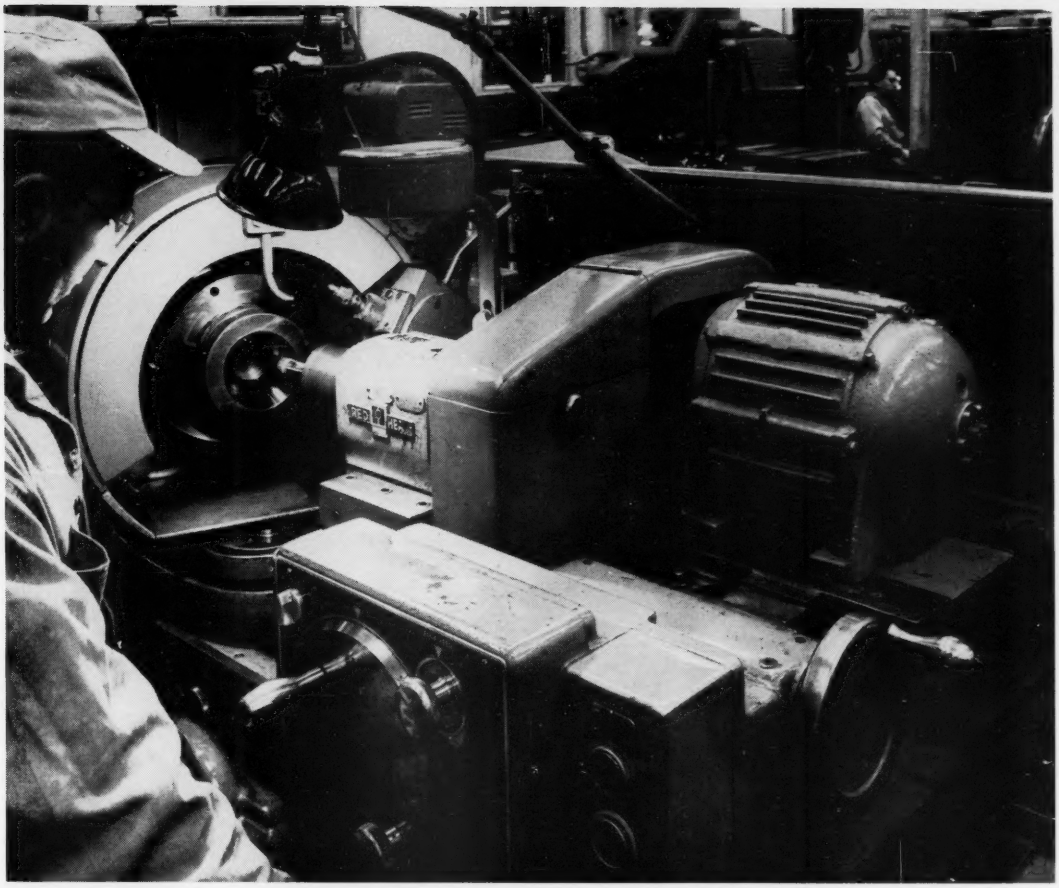
A look at the rewards of incredible accuracy and how they get them

TAPERED ROLLER BEARINGS, accurate to within seventy-five millionths of an in., have been manufactured by the Timken Roller Bearing Co. in commercial quantities. Such incredible accuracy can only be accomplished with equally incredible accuracies in the machines and gauges used to produce these bearings. Company engineers and American machine tool building experts developed a grinder capable of accuracies greater than ten millionths of an inch. This is the way they do it.

The precision grinding machine requires a sturdy base that adequately supports the machine and keeps it stable and immobile. The grinding machine's parts must fall within the base of the machine. The outside diameter grinding machine is leveled with a precision level. The internal grinding machine has a built-in level.

The wheel head slide on the inside diameter grinder is force-lubricated. All moving parts of the ID wheel head must be carefully machined and all fits must be metal-to-metal with no press, yet no looseness. The work head spindle on the ID grinder is further checked by sweeping the face of the chuck with an indicator. A hole is ground on the chuck and this is also swept with an indicator to assure the work head and wheel head spindles are the proper height in relation to each other.

Work head pivots on the face of the chuck make a finer adjustment of the straight and taper alignment possible. The face of the magnetic chuck and the work placed on the chuck must be absolutely flat. If either the face of the work or the chuck is not flat, they will flatten out against each other. If a hole in the work piece is being ground under such circumstances it would be true while being held by the magnetic chuck. After the magnetism in the chuck is released, however, if either the work piece or the chuck face were not flat, they would spring back to their original shape. The hole in the work piece then would be neither round nor straight. Meticulous precaution with wheel



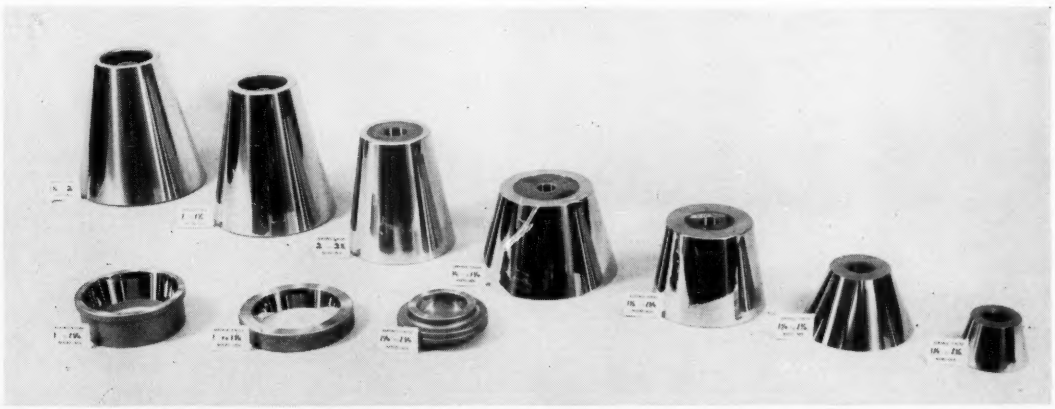
Internal grinder smooths finish to two micro in. and round, straight and bell mouth to 10 m. in., size 20 m. in.

and work head accuracies pays off in improved straightness in the work piece.

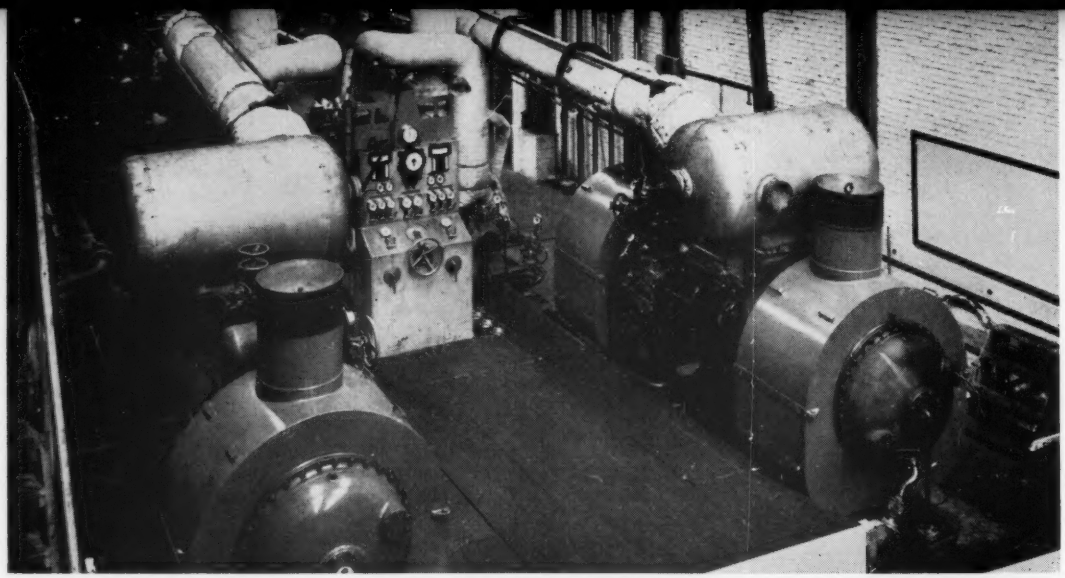
The belt used on the ID grinder work head must be uniform and made of seamless fabric to eliminate vibration. Tension on the wheel head belt must be constant.

Table ways on the OD grinder are lapped and also force-lubricated. The wheel head on the OD grinding machine is driven by a carefully balanced, direct current, variable speed, one-horsepower motor. The work head on the internal grinding machine is driven by a variable speed, hydraulic motor and the wheel head is driven by an alternating current, one-horsepower motor. Legs on the motors are machined so that they set absolutely flat. The motor pulley must run true and be carefully balanced with the motor.

The direct current motors were used for two purposes: 1. to reduce pulsating *Continued on page 84*



These gauges, ground on fine precision grinders suggest the future possibilities of the already amazing art.



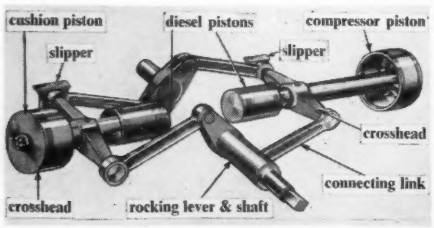
Portable, a free-piston power plant from a ship such as the one below, is put through rigorous yard tests.

Ship above is propelled by French Sigma compressor — a free-piston gas generator pioneered by M. Pescara.

Mechanical components

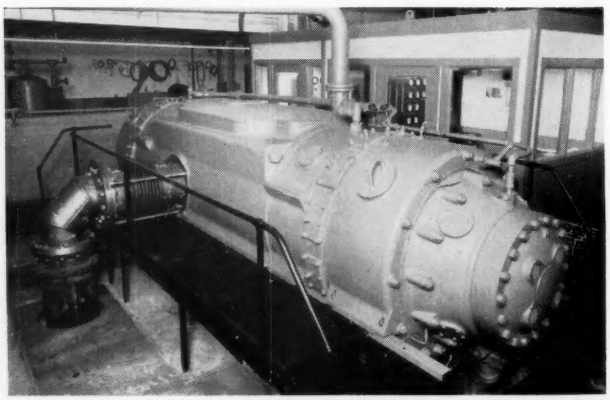
Free-piston engines—Who does what?

It has no vibration — no friction: Why is the engine not used more?



Moving parts assembly which is released from positive kinematic contraints by the direct connection between the two pistons in assembly.

Right, a free-piston engine gasifier made by Cooper-Bessemer, installed in North America.



By J. S. SHAPIRO

ENGINEERING CONSULTANT (GT. BRITAIN)

EVERY DESIGN ENGINEER knows that often seemingly secondary difficulties can become major ones even in the development of a very simple device. It is not unusual, in fact, that the basic design principle must be changed to suit these obstacles. And the successful researching of a new device can be held up for years on this account.

The development of the free-piston engine is a case in point. Its pioneers as far back as the early twenties were Junkers in Germany and Pescara in France, although they worked along different lines.

Junkers, the first to apply the principle of free operation to a self-contained compressor set was experimenting at the same time that Pescara was mostly interested in producing a hot air-gas mixture under pressure to drive a gas turbine. Pescara's arrangement could be likened to a steam boiler driving a steam turbine. It is known as a gas generator or gasifier.

Today, the free-piston mechanism is the heart of the free-piston engine. However, the term "free" is slightly misleading.

The advanced mechanism is an oscillating, direct acting piston-type pressure transformer. It is distinguished by the direct connection between two pistons, which releases the piston assembly from major positive kinematic constraints and makes it a "free" piston.

Nearly all the advantages of the free-piston result from the direct transmission of pressure without the use of a crank mechanism.

What are the advantages?

Reduced cost and weight due to absence of the hardware itself, is one advantage. Others are:

- The elimination of vibration by only one artifice.
- The absence of any but gas conduit connections between individual units.
- The ability to vary the piston stroke in operation.
- The absence of friction losses due to the crank mechanism.
- The ability to operate the power cycle at a high pressure, other things being equal.

One limitation, however, of the free piston principle (which it shares with no other prime mover) comes from the fact that the piston moves according to the forces in the oscillating system. The piston assembly is the principal mass of it and the gas enclosed in the various cylinders is the elastic link. So the frequency of the piston assembly is not a design parameter which can be chosen at will.

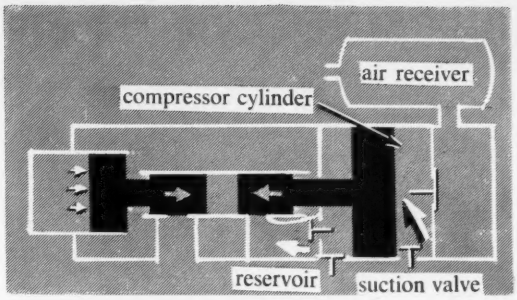
Other limitations of existing free-piston engines are accidental and will be improved by further design.

Still others are inherent in a type of prime mover like the free-piston engine.

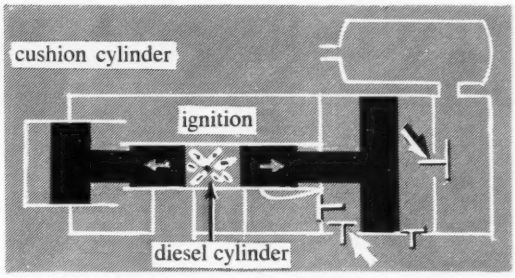
For example, solid fuels can only be used in the free-piston engine after conversion into gas in some form of gas producer.

There are two compressor sets on the market: the French Sigma compressor of 200 cfm output and the British Alan Muntz & Co. compressor that gives 105 cfm. Both sets are designed for a pressure of 100 psi and hundreds of these machines are at work, some under very severe conditions.

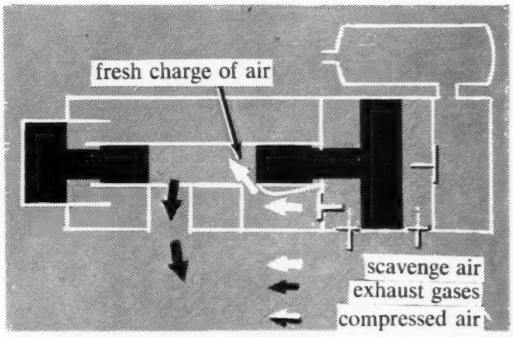
Special features of these units are the spring starter and the auxiliary drive by a small exhaust turbine.



Inward/compression stroke moves diesel pistons in: Inner face of compressor piston delivers scavenge air to reservoir below piston rod: Outer face draws air through suction valve: Fuel is injected, mixture of fuel/air ignites and diesel pistons then move out.



Outward/firing stroke: As diesel pistons move out, inner face of compressor piston sucks in scavenge air while outer face forces compressed air through the delivery valves into air receiver. Meanwhile, cushion piston has compressed air in closed cushion cylinder.



Outer dead point comes as pistons reach outer limit. A fresh charge of air enters diesel cylinder from the scavenge reservoir and helps expel remainder of the products from combustion out exhausts. Air compressor in cushion cylinder makes pistons move out again.

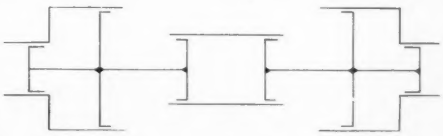


Diagram above shows the design of the free-piston compressor arranged into two compressor stages.

Free-piston engines *(cont'd)*

These free-piston gas compressors have technical advantages over the crankshaft type sets, namely, a 15% lower fuel consumption with 25% less weight.

Of much wider scope in size and variety is the free piston gas-turbine power plant.

In this engine the casing itself is supercharged to the output pressure of the compressor (which, therefore, constitutes the lowest pressure level of the power cylinder) so as to mix easily the power cylinder exhaust with the compressor output.

The three cylinder, diesel, compressor and cushion, can be arranged in accordance with one of the three schemes shown in the diagrams on this and the facing page. In the most prominent scheme, the cushion cylinder is on the obverse side of the compressor piston.

The power cylinder of the free-piston engine is now always on the two-stroke compression ignition (diesel) cycle. The power cylinder of a gas generator unit is not only scavenged by the compressed air produced in the compressor cylinder, but is also highly supercharged to the level of the compressor pressure. The fuel-air ratio, therefore, varies greatly throughout the range of loads and spark ignition is virtually ruled out.

Free-piston gas generators are in production or under development by four manufacturers and differ in physical size, type of layout, and gas cycle characteristics. The principal particulars are listed (see diagrams). The French GS-34 design has the most in-use time behind it and this particular gas generator is therefore a good example to look at.

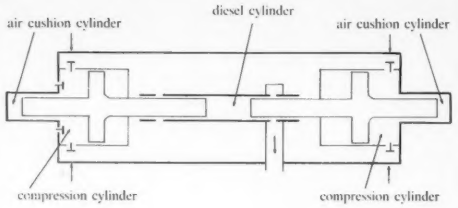
As the diagrams show the layout of the unit is inward compressing.

The control of the power cycle is achieved by the

Table 2
Here is the P. 42 at a glance

Output	105 cfm
Maximum operating pressure	100 psi
Diesel cylinder bore	4.25 in.
Compressor cylinder bore	9.00 in.
Cushion cylinder bore	8.25 in.
Stroke at no load	5.52 in.
Stroke at full load	5.98 in.
Speed at no load	1130 cycles/min.
Speed at full load	1100 cycles/min.
Method of lubrication	Pressure feed to engine. Metered feed to compressor cylinder.
Air receiver capacity	0.89 cu. ft.
Method of starting	Spring.
Fuel pump and injectors	Single element jerk pump and two 2-hole nozzles.
Fuel consumption normal conditions	7 pints per hour (approximately).

Three types . . .



Outward compressing type

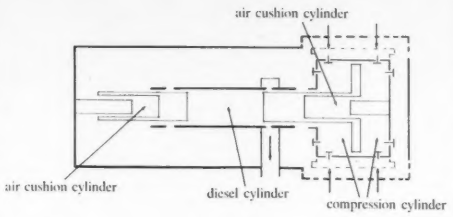
Used in remote locations, the free-

piston itself through the covering and uncovering of ports and so the power cylinder has no valves. The opposed piston layout permits straight-through scavenging from the engine casing through the inlet ports at one end of the cylinder, the exhaust ports at the other end — to the turbine. The flow to the turbine is intermittent and the extent to which the compressor cylinder exceeds in swept volume the power cylinder, at once shows the large amount of air available for scavenging. The off-on flow to the turbine has not caused any blade damage even in plants with a single gas generator. In most plants, units work in pairs, and a simple device ensures the synchronizing of each pair with a phase difference of 180 deg.

The compressor cylinder sucks air to the engine casing. Both suction and delivery valves are automatic, spring-loaded, non-return valves. Their design until recently was a limitation upon the volume and frequency of the gas generator. Recently Muntz in Great Britain, however, has produced an aerodynamic type of non-return, automatic valve. It reduces the total valve area

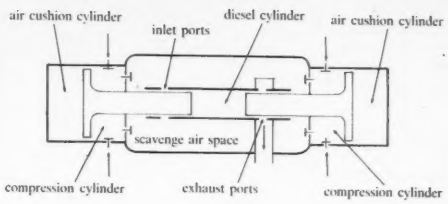
Engine is promising for rail adaption above, due to flexible layout, part-load efficiency, fuel needs.

. . . of free . . .



Double-acting type

. . . piston engine



Inward compressing type

piston engine starts easily, is inexpensive and simple to maintain

to one quarter of the current design and increases the maximum frequency operation to about 2500 cpm.

The free-piston gas turbine power plant can be used in many situations. It's easy starting and good part-load performance are valuable in stand-by units which may be linked to central power supplies. The engine is portable and relatively low in cost. These features coupled with simple maintenance, adapt it for generating and pumping sets in remote localities, or for special (including military) duties. There is no vibration in gas generators and they do not have to be stopped to be reversed. They can be overloaded to an extent comparable only with that of a steam turbine plant. These features make the free-piston engine suitable both for propulsion and auxiliary power units aboard ship. In rail traction, its maintenance, good part-load efficiency, flexible layout, and its burning of fuel oil or even residual oil, make the engine promising.

The total number of gas generators in service at the present time is about 70. One stationary generating set, which provides the electrical power for a chemical plant, has completed over 12,000 hours on fuel oil.

The French Navy now has 18 mine-sweepers in service propelled by free-piston gas turbines. In North America, the Cleveland Diesel Division of General Motors, under license agreements with the French and British development companies, is producing a propulsion plant intended for converted "Liberty" ships. An experimental locomotive, powered by a free-piston turbine plant, has covered 150,000 miles mostly in scheduled service.

Although the free-piston engine has been used extensively, its adaptions have apparently just begun. At present the best selling feature is its reliability. But there are many more improvements which must and can be made to make it work even better. Without doubt they are coming.

These advances will come in the form of increased operating pressures, temperatures and speeds. More refined layouts like the inter-cooling of the power cylinder charge will also improve the engine. ★

Table 3

THE FREE-PISTON ENGINE

Facts About Free-Piston Power Plants

Constructor	SIGMA (France)	Alan Muntz (U. K.)	Cooper Bessemer (U. S. A.)	Baldwin-Lima-Hamilton (U. S. A.)
Designation	GS-34	U. S.-75	R	B
Layout	C	C	A	A
Gas delivery pressure (psig)	50	50	72.5	90
Gas delivery temperature (degree C)	507	500	538	705
Gas power (HP)	1310	450	1750	885
Diesel cylinder bore (in.)	13.4	7.5	14	8.25
Compression cylinder bore (in.)	35.4	20.75	37	23
Stroke (in.)	17.5	10	18.5	11
Frequency (cpm)	600	1100	555	1035

Method

Now you can drill holes of any shape

This ultrasonic drill vibrates instead of turning to offer new freedom

DESIGNED to drill hard and brittle materials such as glass, ceramics, germanium, tungsten and titanium carbides, diamond and synthetic gems, the Mullard 50 watt ultrasonic drill has a vertical reciprocating action. Used with an abrasive slurry it performs all the normal machining operations of drilling, shaping, grinding and polishing.

Rapid cutting is possible because of the continuous, light chipping action of the abrasive, acting between the cutting tool and the surface of the workpiece. The shape of the cut follows closely that of the tool, which is normally made of a soft material like brass or mild steel. Special hardened tools of the conventional kind are not necessary. This means that the user can easily shape a cutting tool to suit any particular requirement.

Since there is no rotary movement, drilling is not limited to circular or symmetrical holes. In fact, intricately shaped holes, difficult by normal methods, can be drilled. There is no stressing or heating of the material and distortion is therefore avoided.

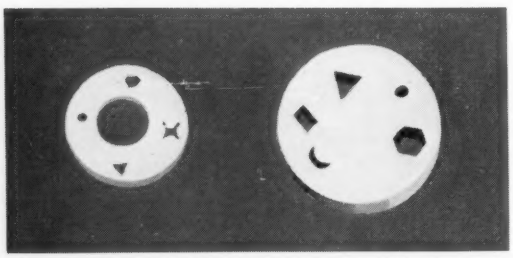
Machining accuracy and surface finish depend on the size of the abrasive particles. Surface finishes of 8 to 10 micro-inches are easily obtained and finer finishes result from using suitable abrasives. As with normal machining a repassing action (equivalent to reaming) can be carried out using a fine abrasive, in order to obtain accurate sizing. Using a 1000 mesh abrasive, the dimensional accuracy of the finishing cut is about 0.0005 in.

The speed of working varies with the material and the size of tool used. A ¼ in. square hollow tool will penetrate soda glass to a depth of 1 mm within 40 seconds, while a similar cut in tungsten carbide would take approximately 10 minutes.

The machine is particularly useful for preparing dies and tools and for machining and finishing materials like ceramics which cannot be molded to close limits.

A larger drill unit, mounted on a floor stand and fitted with a pneumatic feed, is available for work beyond the capacity of this small drill.

The equipment is similar to a normal light bench-type power drill and operates from 110-250v a-c mains. It consists of two units. The drill head, mounted on a bench stand; and an ultrasonic power unit, connected by a single 4-core cable. Controls are limited to a simple tuning control and an on/off switch.



Irregular-shaped holes in components above would not have been possible without ultrasonic drill unit.

What it does in design

- Drills and cuts the hardest material more quickly than is possible by ordinary methods.
- Can drill holes of complex shape.
- Cutting tools are readily and cheaply produced in easy-to-work metals.
- Operation is simple and free from industrial hazard.

The drill head consists of a magnetostrictive transducer coupled to a brass velocity transformer, or matching stub, to the end of which are screwed the various cutting tools. These are turned with a standard BA threaded stud for fitting to the machine, or in the case of complex shapes brazed to threaded studding. Three velocity transformers are provided with each equipment, and have tip diameters of ⅛ in., ¼ in. and ⅜ in. This range of stubs covers all drilling sizes from the smallest possible to the equivalent of a square cutting tool having ⅜ in. sides. The appropriate stud is chosen to suit the particular size of tool being used.

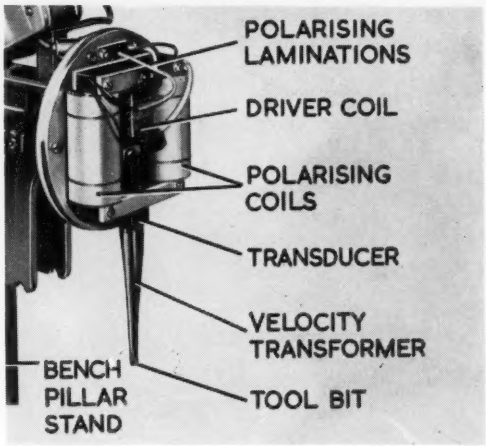
The transducer, which is a laminated nickel stack, is a 20 kc/s half-wave resonant section, clamped at its nodal point. The drive coil is mounted on the transducer, and separate polarizing coils are fitted on a laminated yoke, which flanks the transducer. The brass studs are also 20 kc/s half-wave resonant sections, and are turned with a ⅜ in. BSF stud, which screws into a stainless steel plate brazed to the face of the transducer.

The amplitude of vibration at the face of the transducer is about 0.0005 in., and the three studs magnify this movement in the ratio 2 to 1, 3 to1 and 6 to 1, giving tip amplitudes of approximately 0.001, 0.0015 and 0.003 in.

The drill stand is of conventional type with the drill head mounted on a lever-operated, counter-balanced fitting which slides on a vertical pillar.

The power unit has an ultrasonic output of approximately 50 watts at a nominal frequency of 20 kc/s for energizing the transducer, and also provides a d-c polarizing supply. The circuit consists of a free running, symmetrical multivibrator the frequency of which may be tuned between approximately 16 and 24 kc/s.

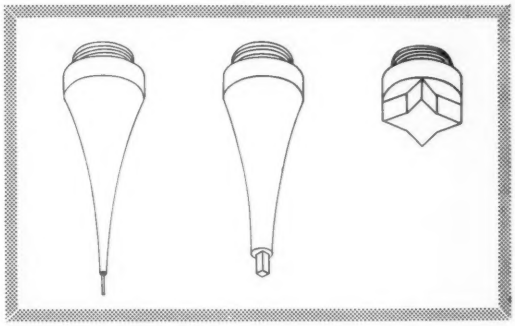
The output is fed into a single amplifying stage that drives two output pentodes in parallel, feeding the transducer via a matching transformer. The low voltage



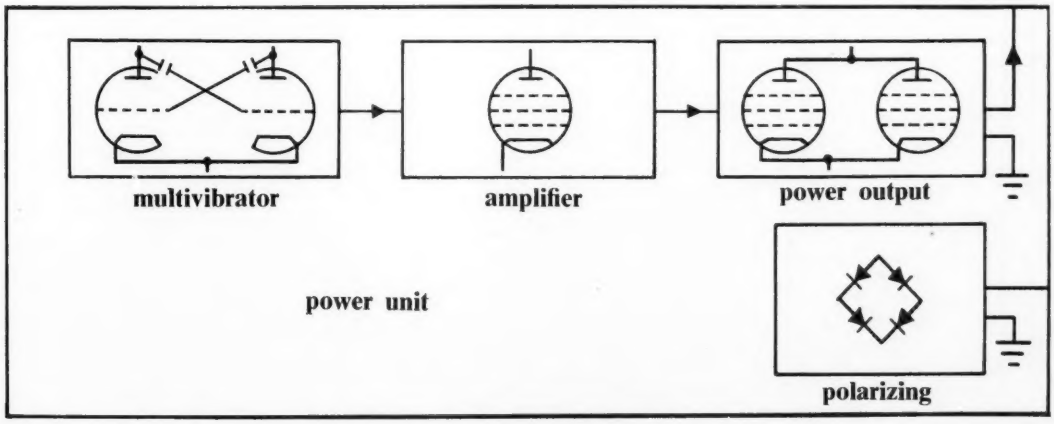
See the drill head close up

Above, drill-head of Mullard 50-watt ultrasonic drill left, shows arrangement, design of components.

polarizing supply is provided from a full wave rectifier.
Hole Size: Variable from 0.006 in. to ⅜ in. across.
Depth of Hole: Normal maximum equals ½ in. This may be exceeded if special stubs are used.
Speed of Cutting: Depends on material and drill size and is proportional to the volume of material removed. Trepanning cutters are preferable. A ¼ in. square, hollow tool will cut tungsten carbide at 0.1 mm. per min.
Accuracy: Dimensional accuracy of about 0.0005 in. is possible on finishing cuts. Surface finishes of 8 to 10 micro-inches are readily obtained.
Abrasive: A water slurry of silicon carbide or boron carbide, depending on the work material.
Matching Stubs: Sizes ⅛, ¼ and ⅜ in.
Electrical Data: Ultrasonic power, 50 watt approx. Ultrasonic frequency, 16 to 24 kc/s. Power supply, 100-150 and 200-250v, 40-100 c/s. 175 watt. ★



Two taper-stub transformers are shown left with the tool tip, and right, heavy tip with a transformer.



What are the drilling stages?
All the stages needed to drill ultrasonically shown in diagram form.

Try the tiny ceramic tube for strength

Tubes get rough treatment today. How can you make them strong enough to stand up to the demands made of them? Ceramics may be your answer

By JOHN R. WHYTE

CANADIAN GENERAL ELECTRIC

IN THIS ELECTRONIC AGE, nearly all tube demands, from military to home entertainment, are becoming increasingly severe. Designers ask for operation at higher frequencies and higher temperatures, along with increased ruggedness and small size. The conventional glass tube has proved its usefulness but it does have its limits, since the sort of glass used for fuses is a weak material which cannot stand a high temperature and is not made to close tolerances.

A new approach to the tube design problem is the micro-miniature ceramic tube developed by General Electric Company. This tube does not use any glass in its construction, the envelope being made entirely of ceramic rings for insulation and metal discs for the connections.

The metal used in the new tube is titanium, which has two unusual properties that are vital for a successful tube. Titanium can be degassed quite easily, and after degassing it acts as a getter or sponge to absorb any additional gas that might be evolved during tube operation. This is in contrast to the behavior of other metals, which give off gas when they are heated during the tube operation. A second feature of titanium is that it has the same expansion as the ceramic, and will make a tight seal which maintains the vacuum in the tube even when heated to a high temperature.

The ceramic tube uses an in-line structure rather than the co-axial structure of most tubes. The heater and oxide-coated cathode are at one end of the tube, and the plate is at the other end. In between is the grid, which is wound from 0.0003 in. diameter wire across a small washer, with 1,000 turns of wire per inch. These dimensions represent a new degree of precision in tube manufacture. To complete the ceramic tube, the various parts are stacked and the assembly is placed in a bell jar. The jar is evacuated and then the tube is heated, thus completing the sealing and exhaust of the tube in one operation.

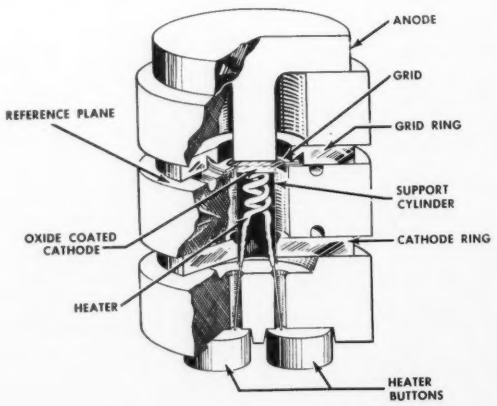
The first tube of this new design is the 6BY4, which is intended as a television amplifier at ultra-high frequencies. At these frequencies, a ceramic tube has two advantages over a conventional tube. The connections are made through metal discs, which form a short connection with a large area, and have a very small inductance to avoid loss of signal. The ceramic tube construction places the grid and its connection between the

These 6BY4 points are important

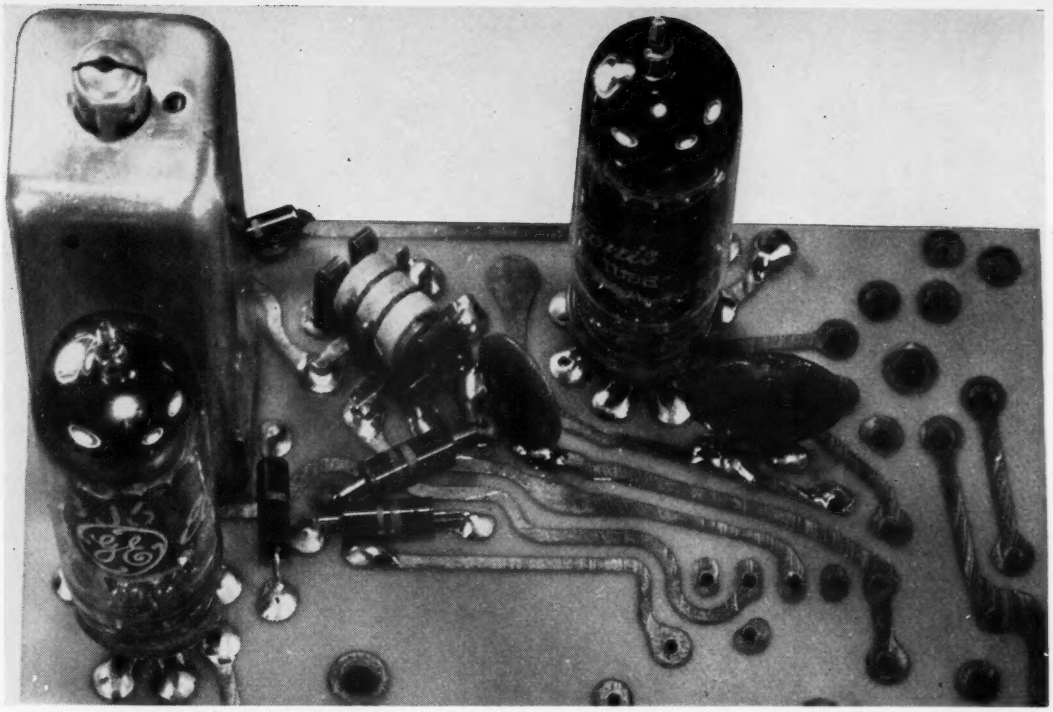
The first G-E micro-miniature ceramic receiving tube—type 6BY4, a low-noise, high-mu triode for UHF-VHF television receivers. This type is about ⅜" long and 5/16" in diameter.

Measured in grounded-grid circuit at 900 mc., with 10 mc. bandwidth:

- Power Gain ..... 15 decibels, approximately
- Noise Factor ..... 8 decibels, approximately
- Filament ..... 6.3 volts
- Plate Voltage ..... 200 volts
- Transconductance ..... 6,000 micromhos
- Transconductance-to-Plate-Current Ratio ... 1,200 micromhos per ma.
- Amplification Factor 100



Metal in micro-miniature GE ceramic 6BY4 is titanium which has the same expansion as ceramic.

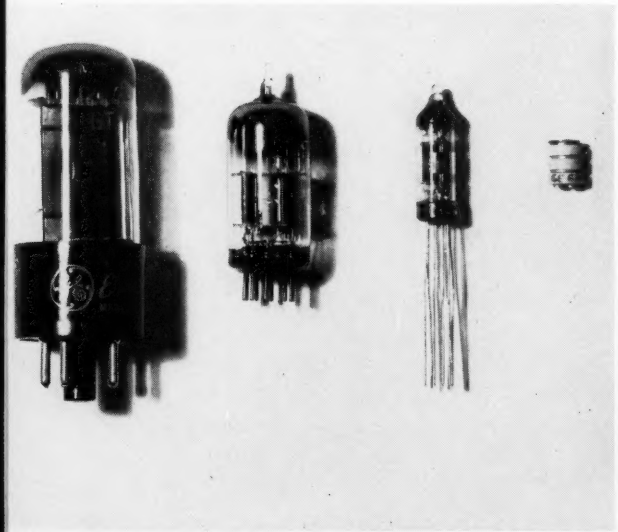


In printed circuits tube is ideal. Socket is integral part of circuit board with friction contacts to elements.

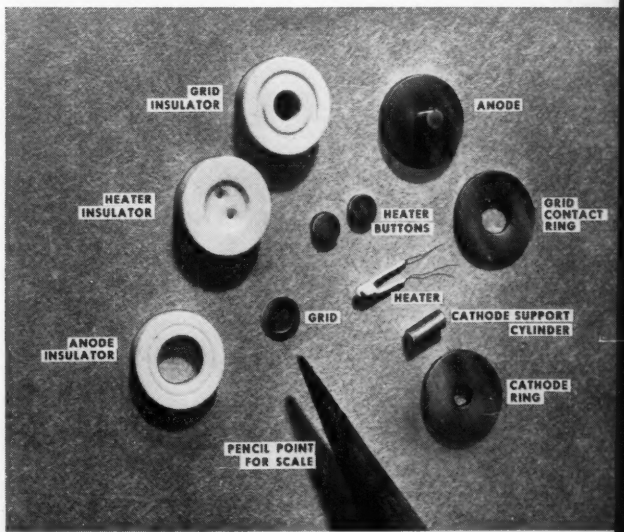
cathode and plate conections, thus reducing the coupling between the input and output circuits. This improved performance is seen in the low noise factor; the 6BY4 gives a 4 to 1 improvement in noise over currently available tubes.

In addition to its smallness and improved high frequency performance, these tubes are more rugged than conventional tubes. This is partly because the ceramic is stronger than glass, but also because the grid is held more firmly than with the usual mica supports, and noise and microphonics are reduced to the vanishing point. The ceramic tube is ideal for high temperature operations in excess of 500 C. The bulky cooling equipment needed for such applications as military aircraft could be eliminated.

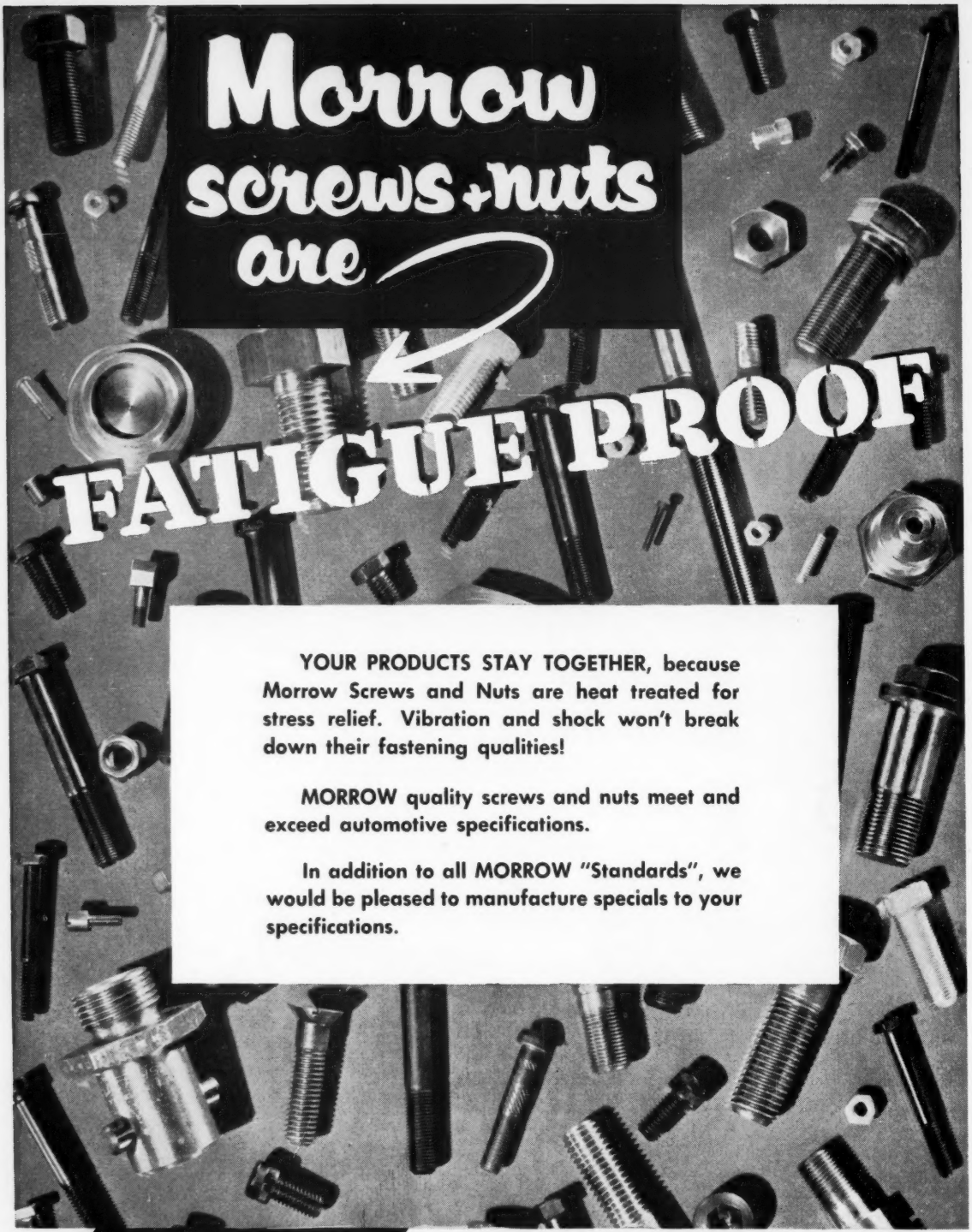
Any electronic equipment requiring motion, high temperature, restricted space and improved high frequency performance is a potential user for micro-miniature ceramic tubes. More uses are in the offing, as even now other tubes of the same type are being designed.



Dwarfed by ordinary tube, left, the micro-miniature 6BY4 is also compared with miniature, sub-miniature.



Disassembled components of the new micro-miniature tube are overshadowed by even the ordinary pencil.



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Charles Beaudry member of CAE's Design and Development Staff, is pictured here working on an original development project.

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New products & components

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Design heavy-duty relay Has time delay of three min.

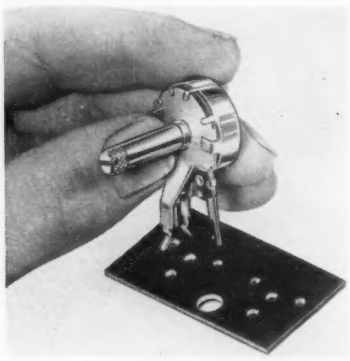
A NEW RELAY, the TR 30, is the newest addition to **Precision Magnetic Devices Inc.** family of thermal and magnetic devices. Designed for heavy duty, its life is long and trouble free since its single pole, normally open or closed contacts are quick make and break in either the single or double throw types.

This 30-ampere unit, equipped with a low current consumption heater coil, can be supplied for an operating voltage of up to 220 volts a-c. A time delay setting, factory adjusted, up to three min. can be obtained with repeatability maintained at a maximum variation of not more than 10%. (200)

• • •

Market snap-in resistor Needs no mount hardware

A SELF-SUPPORTING, snap-in variable resistor for printed wiring has recently been marketed by the Electric Component Division of **Stackpole Carbon Co.** This control, Type LR-70, measures only 57/64 in. diam and stands 7/8 in. off the mounting board. It is



Stackpole plug-in resistor

supported by four legs—the three regular voltage taps, and a larger, case ground leg. No mounting hardware is required since the legs merely snap into the printed wiring board to form a strong support. Terminals are heavily tinlead coated for fastest soldering with dip solder.

These variable composition resistors find wide applications in TV, FM, AM receivers, auto radios and other printed circuits chassis where space and cost must be held to a minimum. Gold-plated ring-spring and contact hub-spring contactors assure smooth, quiet operation. Cases are nickel plated in the modern manner.

The shaft is firmly supported by a 3/32-in. extruded bushing, and may be left round or equipped with flat, screwdriver slot, split knurl, diamond or straight knurl, or tongue. Single or double-pole snap switches are available with ratings from 15 amps, 15 volts dc to 6 amps, at 125 volts ac-dc.

The LR-70 is rated at .75 watts for values above 10,000 ohms, and .50 watts below 10,000 ohms. (201)

• • •

Make bread board lab kit Solves engineering puzzles

A PRACTICAL, LOW-COST, complete kit of laboratory precision instrument components consisting of over 655 different precision instrument parts such as gears, shafts, differentials, bread-board plates, hangers, bearings, is being marketed by the **Precision Instruments Components Design Corp.**

This kit of parts is complete in every way and has all parts necessary to solve any mechanical or electronic problem. Material is designed for re-use.

This kit can be used for military engineering or development contracts, universities, laboratories, educational institution and for all electronic application. It is contoured in a carrying case, felt-lined to protect the precision instrument parts and is complete with tools to assemble and disassemble the parts. (202)

• • •

TV set cost cut? Disc cathode may-Superior

A DISC CATHODE which permits manufacturers to use a narrower glass neck in television tubes, reducing the deflection yoke to ultimately save in production costs of the television sets, has been produced by **Superior Tube Company.**

Introduced at the Radio Engineering Show in New York, March 19-22, the new unit has the same nickel shank and cap and uses the same heater as the company's standard ED 1-2 disc cathode but has a smaller diameter ceramic disc.

The diameter of the ceramic disc in the new unit is .365 in. plus or minus .005 in. in contrast to the standard .490, with the same tolerance. The outer diameter of the tube attached to the disc is .121 in., plus or minus .001 in., in both the new unit and the standard.

The new narrow neck disc cathode is one of a complete line of cathodes made by Superior for use in electron tubes of all types that are being manufactured.

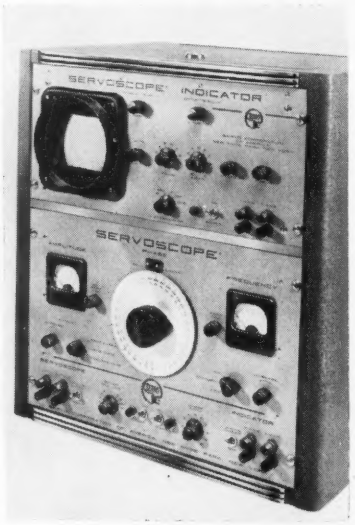
The company also manufactures stainless anodes, glass sealing tubing and other fabricated tubular parts for use inside electron tubes. The firm makes small-diam mechanical tubing in 63 standard analyses for general industrial and military applications, including electrical and electronic products. (203)

• • •

Re-design instrument Is human-engineered

A NEW SERVOSCOPE designed on principles of human-engineering is now being manufactured by **Servo Corporation of America.**

This instrument is both a multiple signal generator and phase angle indi-



New instrument from Servo

cator. Its face was redesigned as a result of a nation-wide survey of engineers and technicians. Based on these findings, dials, switches and information display were human-engineered to reduce fatigue and increase accuracy.

The instrument provides a direct method for measuring gain and phase shifts of any component or system in the subsonic frequency ranges. By turning the big phase dial, phase lead or lag is shown within an accuracy of 1 deg. Its various signal outputs include sinusoidal modulation in a suppressed carrier envelope, sinusoidal and square waves.

Its uses as a test instrument are many and varied, ranging from automatic flight control design to testing computer response, checking vibration, testing frequency response of electro-hydraulic servosystems, simulating rate gryo and training.

A matched cathode ray indicator, available with the device, offers low drift and high stability throughout the carrier frequency range. (204)

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DIVERSIPIPE . . . the super flexible rubber pipe with "Divers" uses for conducting corrosive chemicals and abrasive materials

Diversipipe available with either Full Face Flanged End or new type Beaded End as illustrated.

Diversipipe has many special features for conducting corrosive chemicals and abrasive materials more efficiently—more economically. It is light, is easily and quickly installed, wire reinforced wrapped fabric construction resists crushing or kinking and is non-collapsing under suction.

This rugged rubber pipe is in regular service conducting foundry sand and mine back fill. It is also ideal in such plants as vinegar, salt, cement, stone crushing—in grain elevators, coal mines, and copper refineries. Diversipipe is built to give outstanding service under the most punishing conditions.

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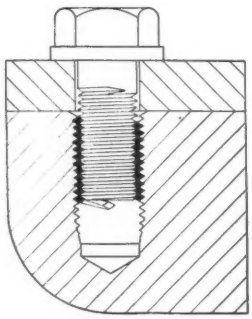

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NEW Products *(Cont'd)*

AN AUTOMATIC TRI-FILM processor produced by **PSC Applied Research** is portable. It will process and automatically dry 16 mm, 35 mm and 70 mm film. Loading and process facilities for various sizes of film have been given particular attention in its design.

Four lengths of 16 mm film or two 35 mm lengths can be handled simultaneously, or one 70 mm length by the processor known as T246 Mark 2.

The film magazine holds four 400-ft 16 mm films, two 400-ft 35 mm films or one 400-ft 70 mm film, spooled or on cores. Larger magazines can be provided on special order.

Three basic speeds of 1½, 3 or 6 ft per minute can be changed by a simple belt adjustment. Much higher speeds in the same ratios are also possible. Further fine control over processing is obtained by a special programing assembly which can be adjusted to change the loop length in each individual processing tank.

The film is drawn from a light-tight magazine, formed into loops in the successive process tanks, transported at preselected speed and dried in a forced hot air chamber, after which it is wound on take-up spools. Tendency-driven take-up shafts are used to assure uniform spooling. No lower rollers are used, as the upper roller system of the equipment automatically forms loops of the correct length in each tank. Processing is controlled by a mechanical program unit.

Two pairs of tanks

The first two tanks are used for developing, the second pair for fixing and the last two for washing. However, many combinations of tanks and processing solutions may be obtained by changing Saran conductors on the liquid distribution system.

Positive-drive diaphragm-heater pumps are installed on one or more of the first four tanks, according to customer requirements. Running water must be provided for the wash tanks.

Separate temperature control of the processing solutions is possible on each tank over the range 60 to 110 deg F, within 1 deg F.

The need for stop baths and interbath rinses, normally required in many processes, is virtually eliminated because of a positive squeegee roller design. The rollers cause surface liquid to run back into each tank so that a minimum of solution carry-over occurs from developer and fixer tanks.

A high-efficiency blower system and electrical heating ensure rapid drying in the machine and the latest high temperature chemical resistant plastics and type 316 stainless steel are used in all areas contaminated by chemicals. (205)

The 'why' of Nylon

(Continued from page 33)

job is simplified if they are placed at right angles to the parting line. They should be firmly anchored against stress by the use of a diamond knurled surface. The layer of material around an insert should be at least as thick as one quarter the diameter of the insert. This allows for mold shrinkage without setting up high stresses. Additional material should be allowed when this section is under high stress.

The proof of a design is actually in the eventual testing of the product to see if it works. Well-designed nylon products have shown that they can undergo rigorous testing, yet give top service on the job.

Nylon gears are operating without lubrication in textile looms, greatly reducing losses due to product contamination resulting from contact with messy lubricants. Nylon bearings function quietly in automobile brake pedal cross-shafts, where lubrication is not easy.

Nylon coil forms are used in radios because they are tough enough to do away with the problem of breakage during winding.

They can be made with thin wall sections that are highly efficient, however. Nylon door lock wedges are used on car doors because they can withstand impact, yet do not screech or gall even though unoiled.

These successful uses were possible due to carefully considered design, and a broad understanding of the future in this new and useful engineering material. ★

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for Accurate Control of Air, Water, Oil, and Other Fluids

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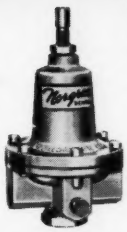
Diaphragm Type Valves
Automatically protect fluid lines and connected equipment from damage resulting from pressure build-up. ⅛" to 1" pipe sizes.

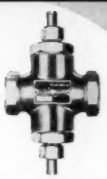


Pop Safety Valves
Prevent build-up of dangerous, excessive pressures on air tanks. ⅛" to ½" sizes.

Low Flow Relief Valves
Small, inexpensive, valves for relief at low rates of flow. ⅛" and ¼" sizes.

FLOW CONTROL VALVES

Two-Way and Single Way
For accurate control of air and hydraulic cylinders. Two-way valves provide controlled flow in both directions; single-way valves provide regulated flow in one direction with full flow in the opposite direction. Also for flow control by means of adjustable metering on fluid lines. For pressures up to 250 psi on air and hydraulic systems; for pressures up to 125 psi on steam and hot water systems. ¼", ⅜", ½" pipe sizes.



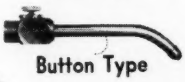
Two-Way Valve

NEEDLE VALVES AND COCKS

For controlling the flow of air, liquids and gases. For pressures up to 250 psi. Machined from brass bar stock. Leakproof. Double female, male and female, double male, male and male cock.

BLOW GUNS

Lever Type



Button Type

For controlling the direction and flow of compressed air for removal of dust, lint, wood or metal chips, water and other foreign materials from parts in production and from machinery. ¼" and ⅜".

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Letters

Readers' viewpoints . . .

• We have read with great interest the article "Electronics Products review to bring your knowledge up to date," by Ian Dutton and Larry Eggleton (DESIGN ENGINEERING, January). We would appreciate knowing whether reprints of this article are available. We are interested in a quantity of 50 and if there is a charge — please let us know.

GEORGE W. MOUSEL
Perkin Engineering Corp.
California.

Those editorials

• It was encouraging to read your editorial "Why not tell the Commission?" (DESIGN ENGINEERING, March). It is pretty awful that so little development work is going on in this country.

It seems to me that newly graduated engineers have more or less got to head for the U. S. if they hope to get anywhere worthwhile. It is not just that more money is paid down there (although that counts too) but there are so many worthwhile jobs for engineers to tackle.

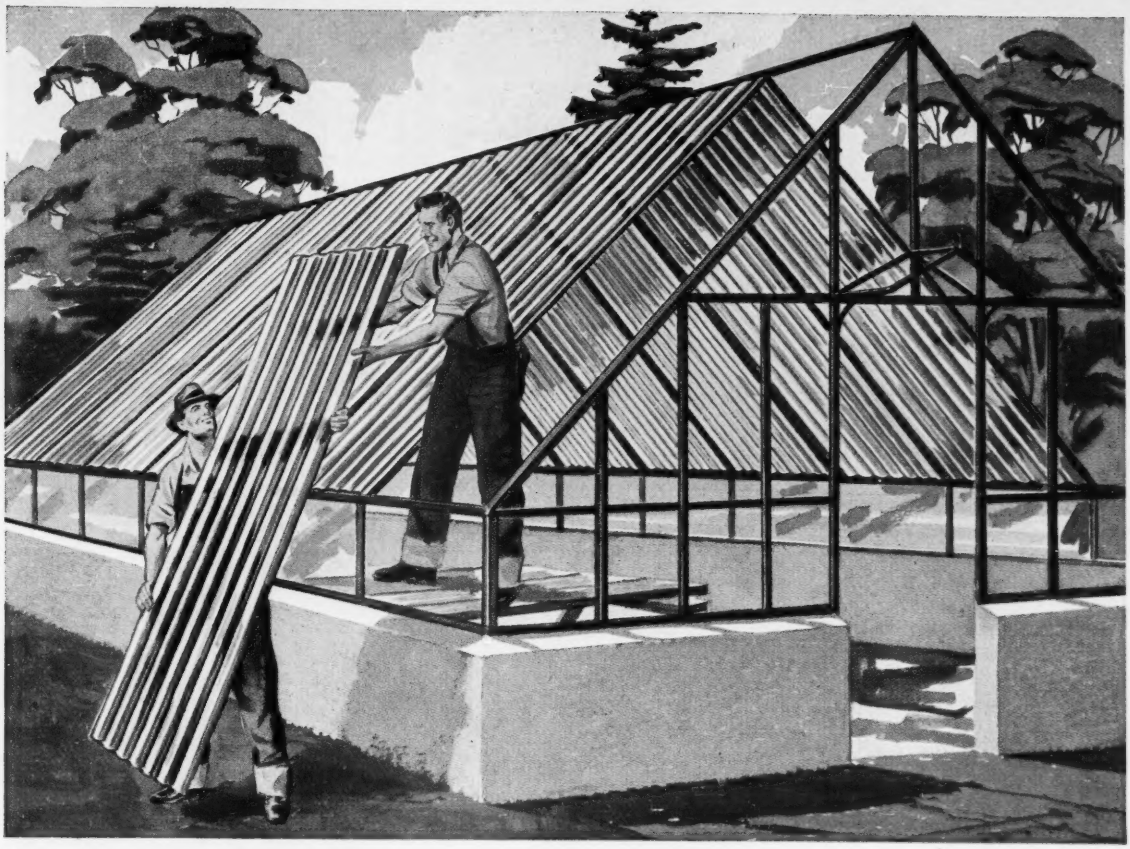
Everybody knows that development work is expensive. But surely we are reaching the stage where we can find ways to pay for it. Manufacturers who take a fast plane trip to New York and come back with a license arrangement to make out-dated American models may feel they are doing themselves a bit of good, but they are not doing much for Canada.

I hope you keep plugging for independence here. Then young engineers will be able to make a proper contribution. And they will feel able to stay in Canada with the hope of a career which is not only rewarding but interesting.

BRIAN BREEDON
Student
Toronto

• You say in your January editorial that you plan, inter alia, to assist engineers toward a "higher status." Now, in my view, you have quite a point there!

It is very disturbing indeed to see how control of industry is slipping into the hands of professional administrators whose specialty seems to be to know nothing—except how to read a balance sheet. Maybe you can help the engineer



Vibrin builds a hardy perennial

THIS GREENHOUSE made from Vibrin translucent sheeting is practically indestructible. Weather extremes of heat and cold will not cause warping, sagging, or surface cracks. Vibrin translucent sheeting is also immune to the effects of moisture; it will not rust, scale, mildew or rot. And, this sheeting is shatterproof! Even severe impact from stones or other objects leave it intact. It's also ideal for carports, breezeways, awnings, skylights, and a host of other uses.

Translucent sheeting is only one of many products made of Vibrin, Naugatuck's polyester resin. Vibrin is also finding wide acceptance in the manufacture of fishing rods, sports car and truck bodies, boats, chemical piping, machine housings, aircraft parts and many other applications.

When reinforced with glass fibres, Vibrin is many times stronger than steel on a weight basis. It is resistant to most acids and alkalis. And most important, Vibrin is extremely easy to form. Molds and tools are inexpensive, and pressure and heat are not required.

For information on how Vibrin can help your products, contact Naugatuck Chemicals in Elmira, Ontario or branches shown below.

Other NAUGATUCK Plastics

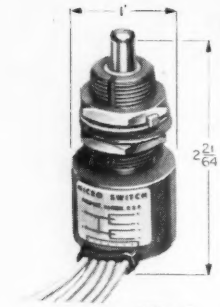
MARVINOL
Vinyls offering good physicals, easy processing, low temperature flexibility, and resistance to oils, acids and wear.

KRALASTICS
Molding and extrusion compounds combining the rigidity of plastics with the tough elastomeric properties of rubber.

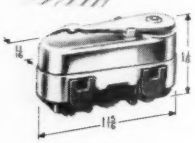
Naugatuck Chemicals
DIVISION OF DOMINION RUBBER COMPANY LIMITED
Plant & Sales: ELMIRA, Ont.
Branches: Montreal · Toronto · Winnipeg

MICRO SWITCH PRECISION SWITCHES

a complete line of environment proof switches for the aircraft industry



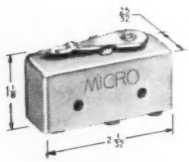
Cylindrical Environment-Free Switch is a compact, completely sealed switch for use on landing gears, flaps or other exposed locations. Provides performance and versatility of switches several times its size and weight.



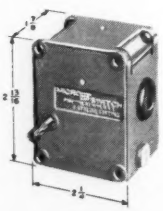
Hermetically Sealed Basic Switch with metal to glass seal is suitable for use in any type of environment and at any altitude with no effect on its precision operation. Mounting holes are on one inch centers.

Sealed Subminiature Switch is the smallest, lightest weight switch of this type available. Completely sealed . . . designed to give trouble-free operation in a temperature range from minus 65° to plus 180°F.

Hermetically Sealed Split Contact Switch with double-throw contact arrangement suitable for controlling two isolated circuits. These switches may also be considered explosion-proof . . . can be used near fuel tanks without danger of igniting escaping vapors or liquids.



Rugged aluminum housings for all MICRO SWITCH environment-proof switches protect the enclosed units from damage and provide a way of mounting the assembly from either side. Holes and slots permit drainage of moisture which might collect in the housing.



MICRO SWITCH has developed a number of small, lightweight precision switches with outstanding performance characteristics to fulfill the rigid requirements for aircraft use. These switches are available in a wide variety of sizes, weights, actuators and electrical characteristics.

MICRO SWITCH
A PRINCIPLE
OF GOOD DESIGN

For complete information about MICRO SWITCH precision switches or for engineering assistance in solving aircraft switching problems, write us care of Dept. DE-AC-4.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO. LTD.

LEASIDE, TORONTO 17

develop a more authoritative voice in the line of business he creates.

Parry Sound — JAMES PREED

Reader Preed will be interested in this comment: "I was told recently that the top industrial management of well over half of our 150 largest corporate enterprises is engineering trained." From Alfred P. Sloan, Jr., Chairman of the Board, General Motors.—Ed.

Thank you — from readers

• I am taking this opportunity to express my personal thanks and those of my company for the kind assistance that you have rendered us in obtaining a copy of the Tin Research Institute report.

The report was received a few days ago and the information it contains will certainly be of assistance to us.

I would like to add that we were impressed by the expeditious manner in which you arranged for us to obtain this report.

C. R. MITCHELL
Anthes Imperial Co. Ltd.
St. Catharines.

• Thank you for your letter of March 7. It was very gratifying to learn that my article on noise (DESIGN ENGINEERING, March) was published. Judging by the number of letters received direct in this office, it must have had a good reception.

We would like to have some copies of your magazine containing this article — perhaps you would arrange the dispatch of 12 copies.

I also wish to thank you for the cheque.

S. A. RYBB
Ottawa. *Dawe Instruments Ltd.*

• Thank you very much for the copy of DESIGN ENGINEERING, March issue. The story on clad steels was excellent.

I will advise you whether reprints are desired. I hope, in the months to come, we can find other stories which will be of interest to your publication.

JACK FROST
New York. *Manning Public Relations*

Address wanted

• Please oblige us with the address of the company responsible for the development of the Al-Fin process as described in your issue of March 1956.

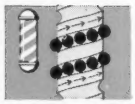
H. SOLOMON
Montreal. *Home Steel Products Ltd.*
Address sent.—Ed.

HOW MANY POSITIONING PROBLEMS CAN THESE AMAZING UNITS SOLVE FOR YOU?

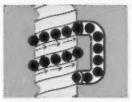
Frankly, we don't know. Almost daily we hear of some new application that never occurred to us. But we do know this: electronics engineers are achieving the "impossible" with Saginaw ball/bearing Screws and Splines, particularly these miniature sizes, from 1½ to 3 inches long.

CHECK THESE UNPRECEDENTED PERFORMANCE ADVANTAGES:

Saginaw ball/bearing SCREWS



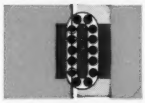
Nut *glides* on steel balls. Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

Saginaw ball/bearing SPLINES

The *Saginaw b/b Spline* radically increases the efficiency of transmitting or restraining high torque loads. Instead of *sliding* against each other, the mating surfaces *glide* on rolling balls.



The steel balls recirculate in closed circuits formed by mating longitudinal raceways spaced around the circumference of both inner and outer splines. Guides return balls to starting point.

UP TO 5 TIMES MORE EFFICIENT

Up to 95% efficiency guaranteed in transforming rotary to linear motion; over 80% efficiency, linear to rotary. Require less than 1/5 as much torque as conventional Acme screws for equal output.

SAVE SPACE, WEIGHT, POWER

Permit much smaller, lighter motors and auxiliary equipment. Saginaw b/b Screws have been built from 1½ inches to 39½ feet in length.

PRECISE POSITIONING AND SYNCHRONIZING

Machine-ground types provide precision control within fractional thousandths of an inch, plus perfect synchronization of two or more movements.

OPERATE IN VERY ADVERSE ENVIRONMENTS

Saginaw b/b Screws have been designed and built to operate from −75° to +900° F. Even if lubrication fails or cannot be originally provided, they will still function with remarkable efficiency.

LONG, DEPENDABLE SERVICE LIFE

Accurately predictable life engineered to design requirements. Special Gothic arch groove design and multiple circuits assure dependable performance.

40 TIMES LOWER FRICTION COEFFICIENT THAN ORDINARY SLIDING SPLINES

By applying the same basic gliding ball principle pioneered by Saginaw in the ball/bearing screw, this revolutionary new kind of spline makes practical new engineering designs never before possible.

TRANSMIT OR RESTRAIN HIGH TORQUE LOADS FAR MORE EFFICIENTLY

In any application where column length must change under torque load, the Saginaw b/b Spline offers unprecedented freedom from sliding spline restrictions.

WIDE CHOICE OF ATTACHMENTS

Can be fitted with integral gears, clutch dogs, bearing and sprocket seats or other attachments for use with electric, hydraulic or pneumatic units.

WIDE RANGE OF SIZES AND TYPES

Saginaw b/b Splines have been designed from 3 inches to 9 feet in length, and from ⅝ to 3¾ inches in diameter. To convert push-pull to rotary motion, helical types are available with very high leads, ranging from 20:1 to 100:1.

Saginaw

ball bearing Screws & Splines

MAIL COUPON TODAY FOR NEW ENGINEERING DATA BOOK

Saginaw Steering Gear Division
Ball Bearing Screw & Spline Operation
General Motors Corporation
Dept. 4W, Saginaw, Michigan

Please send your Engineering Data Book to:

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Quotes

Points from current papers and speeches

Hi-Vac metallurgy expert trained in few hours — CEC

"QUALITY TESTS check Vacuum Coating" is the title of an article in **CEC Recordings,** (Volume 9, No. 7). A series of revealing tests check the quality of metallized finish on plastic clock faces and other parts which have been coated under high vacuum with Consolidated vacuum equipment.

Application of the high-vacuum metal-evaporation technique to obtain metallic finishes on plastics and glass has become a standard practice in industry. First experimental and now full-scale production systems have been designed to use this same method for bright metal finishes on metal stampings, die, sand, and slush castings, extrusions, spinnings and turnings. (See Design Engineering, Oct. 55.)

High-vacuum metallizing is still relatively new. Consequently, it is just now finding a stable level of general usage. However, this metal-finishing method will replace electroplating and silver-reduction plating in many commonly accepted applications, and will open the door to countless new uses.

Vacuum metallizing is simple and inexpensive. A few hours' training makes an employee an expert in the metallizing operation. Just a few ounces of aluminum cover thousands of parts. The process works as well with basic metals as with plastics.

Coating parts with aluminum under high vacuum and applying various lacquers can give them the attractive appearance of gold, silver, copper, or a whole rainbow of other metallic colors.

Stringent tests show that the metallized finish is durable and that rough usage leaves its color, shine unmarred.

• • •

Turbine needs improvement Austin scheme slow

IN A RECENT talk, **Dr. J. H. Weaving,** head of Austin Gas-Turbine Research, stated that a turbine power unit could now be constructed suitable for modern production methods and current road conditions. (See Design Engineering, March '56.)

He stated that much work remains to be done on improvement of heat-exchanger and other component efficiencies before cost and fuel consumption can be brought within acceptable limits. The target is to produce a power unit with brake thermal efficiency equivalent to that of a modern Diesel engine.

The Austin turbine runs on diesel fuel, because of British regulations, which forbid the use of paraffin in motor vehicles for tax reasons and so that the fuel can be taken from existing filling stations.

When starting, the diesel oil is fired by an electric igniter plug taking the discharge from a condenser. Two combustion chambers were used, at first, but it was not always possible to ignite them simultaneously. On one occasion a lot of neat fuel reached the turbine, where it emulsified, was ignited, and damaged most of the blades. Since then, only one combustion chamber has been used.

It would seem, therefore, that no progress has been made with the scheme which Austin patented some years ago, providing for several combustion chambers, and a compressor with a movable shroud, so that some chambers could be put out of action and compressor output reduced to improve fuel economy.

• • •

Baldwin markets gauge kit Tests show high fatigue life

Details are given in Testing Topics (Baldwin-Lima-Hamilton Corp.) of SR-4 foil strain gauges.

Gauges are now available in 1 in., ½ in., and ⅜ in. gauge lengths made from Nichrome, Nichrome V, and Advance foil. When applying these grids, a precoat of cement is applied to the specimen and partially or fully cured.

A second coat of cement is applied over the precoat and the grid embedded while the cement is still wet. After removing the carrier, the gauge, except approximately ¼ in. of each tab, is covered with a third coat of cement. After curing the cement, leads are attached by spotwelding to the uncoated portion of the tabs.

Recently Baldwin has placed on the market for experimental use up to 150 F a foil strain gauge kit containing 20 gauges and enough cement for applying the gauges. The gauges supplied have a 1 in. gauge length and a nominal resistance of 120 ohms and consist of an Advance foil grid bonded to an epoxy resin carrier.

Application is made without removing the carrier, in essentially the same manner as applying an SR-4 gauge. Preliminary tests of the foil gauges indicate a high fatigue life. This is believed to be chiefly due to the elimination of soldered joints within the gauge which have inherent stress concentrations due to discontinuity of size between the grid and the gauge leads. It also appears possible to use higher currents with foil gauges because the foil has more surface area for heat dissipation.

On structures where the dissipation of the active and dummy gauges can be matched and enough heat can be dissipated so that the gauge temperature will not exceed the recommended operating temperature, higher currents and simplified instrumentation may be used to advantage. (See Design Engineering, August '55.)

• • •

Nuclear quest expands Metallurgist key researcher

IN THE QUEST toward economic power from nuclear fuels, physicists, chemists and engineers are looking more and more to the metallurgist, states **Canadian Isotope Newsletter,** Vol. 5, No. 2. The solution to the metallurgical problem is undoubtedly the key to the successful use of atomic energy as a source of power.

V. P. Calkins, of the General Electric Co. nuclear propulsion dept., has put the metallurgical problems in four categories: (1) there are physical and mechanical problems due to the internal heat generation. Heat liberated inside a fuel must be able to pass to the coolant or the system will simply melt and vaporize. (2) Nuclear properties of reactor materials must not interfere with the fission process. The fuel must capture neutrons and use them efficiently, whilst the moderator must slow them.

Other structural materials must have as little effect on neutrons as possible. (3) Corrosion of sheathing around fuel elements, for instance, would release radioactive materials to contaminate the whole system and endanger operating staff. (4) Radiation damage is done to both metallic and nonmetallic materials when gamma radiation or fast neutrons change the arrangement of atoms in the lattice of solid material.

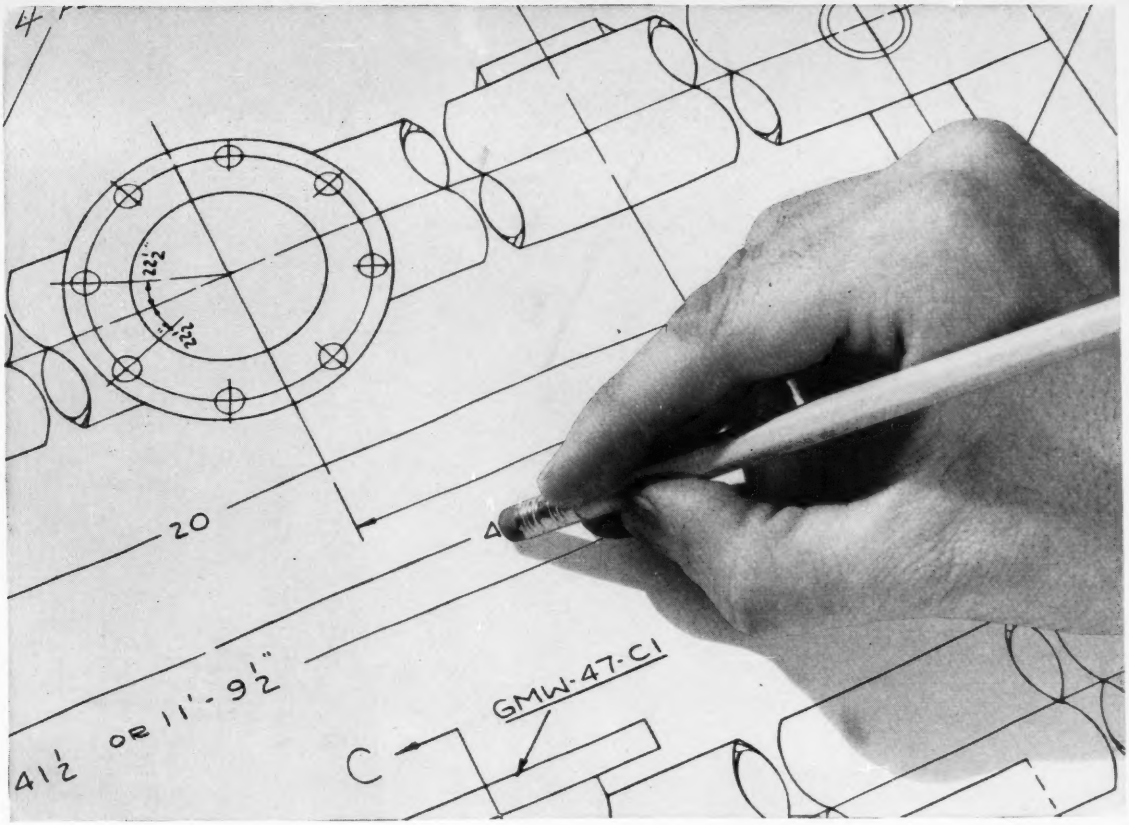
• • •

Fluid lubs use increases But semi-solid often best

THE SUBJECT of grease analysis was chosen for the January, 1956 issue of Lubrication (The Texas Company).

The petroleum testing manual of the American Society for Testing Materials defines lubricating grease as a solid to semi-fluid product of dispersion of a thickening agent in a liquid lubricant. Other ingredients imparting special properties may be included.

Though fluid lubricants are used in greater volumes, it should be remembered that in nearly every machine there are critical areas where a semi-solid lubricant provides the optimum in lubrication.



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Every draftsman will welcome this short cut made possible by intermediates on Kodagraph Autopositive Paper Translucent. New design details can be added immediately with pencil or ink—an hour or more saved in revising a large drawing.

Be sure to remind your customers about this advantage of Autopositive Paper Translucent. And while you're at it, give them a run-down on all the other jobs you can do with Kodagraph Reproduction Materials.

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"The big NEW PLUS in engineering drawing reproduction"

- **Kodagraph Autopositive Paper Extra Thin** for high-quality photographic intermediates at lowest cost.
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Philadelphia's Convention Hall, home of the Design Engineering Show May 14-17.

Design Eng'ng Show will be big and good

AMERICANS, as the whole world knows, enjoy doing things on a big scale. And when they do them big, they seem to do them very well.

All the signs are that they are going to do something big and well again in Philadelphia next month with the world's first Design Engineering Show opening on May 14 in Philadelphia's Convention Hall.

The organizers, Clap and Poliak of New York, are full of extrovert optimism about the project. More than 12,000 people are coming, they say. And these 12,000 will represent every big industry in North America.

Thousands of components and materials will be on view. Standing beside them will be technical experts ready to explain the mysteries and possibilities of the products.

There can be no such person as a manufacturer who will not find something to interest him at this show. However, seventy-three industries have been named as being specially well served by exhibitors.

Samples from the list: Agricultural equipment; air conditioning; aircraft and automobile; ships; business machines; buses and trucks; chemical processing; construction machinery; diesel engines; electrical appliances; electronic equipment; lumber and saw mill machinery; welding equipment; wire making machinery; and so on.

Manufacturers have, for the most part, been shy of revealing the products they plan to put on view. But some have given brief details.

Stokes Molded Products are going to demonstrate the corrosive resistance of unplasticized polyvinylchloride. **New Hermes Engraving Machine Corp.** will be marking very hard surfaces with a new tracer guided electric are etching unit. **Post Machinery Co.** will be showing their new electronic counters with speeds up to 5,000 per second.

Linde Air Products will be demonstrating all sorts of uses for their flame-plating process. **Acme Steel Co.** will

LOW COST—HIGH QUALITY

Relays-a-Plenty

Potter & Brumfield, with its many years of Engineering and Production experience, builds relays to all quality levels.

Relays from the most exacting to the simplest in operating specifications are readily available at P&B.

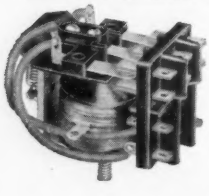
Small or Large quantity orders receive the same careful attention by the people that have the "Know How."

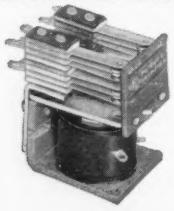
Let Potter & Brumfield engineers become part of your design group in selecting the correct type of relay to meet all requirements.

For quick delivery over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

Send your specifications for samples and quotations.

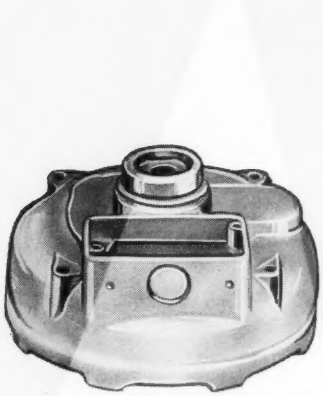
Potter & Brumfield inc.
PRINCETON, INDIANA
SUBSIDIARY OF AMERICAN MACHINE AND FOUNDRY COMPANY

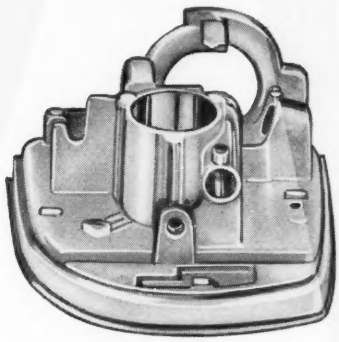


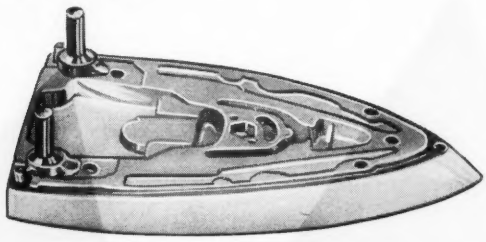


PROMPT SERVICE
TOP QUALITY

ON ALUMINUM DIE-CASTINGS







Need Aluminum Die-Castings in a hurry? You can rely on Hoover to turn out a quality job . . . strictly on schedule! Our affiliation with the Hoover Company's U.S. Die-Castings Division enables us to expertly tackle any aluminum die-casting problem you may encounter . . . and come up with savings in time, material and labour as well. Worth looking into, don't you think?

HOOVER

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THE HOOVER COMPANY LIMITED, HAMILTON, CANADA

A5-348

Engineering Show

(Continued)

have the newest wire stitching machines on view.

A new approach to the problems of fastening hubs to a shaft will be shown by **U. S. Automatic Corp.** with their grip springs. **Wagner Electric Corp.** will be exhibiting their latest lines in electric motors.

New metallized ceramic coatings for use with hard or soft solder will be shown by **Frenchtown Porcelain Company.** A completely new self-lubricating roller chain will be shown by **Whitney Chain Co.** to prove that chain drives can be used where normal lubrication may contaminate.

Hunter Spring Co. will be there with a mechanical element which can be made to act as a zero gradient spring. They promise to show many new ideas

(Continued on page 74)

Who will be exhibiting at the Show?

(Bold figures are booth numbers)

A

Acme Steel Co. **440, 442**
Air Maze Corp. **105**
Alemite Division, Stewart-Warner Corp. **139**
Alloy Metal Wire Division **405**
Aluminum Company of America **340, 342, 439, 441**
American Nickeloid Co. **416**
American Society of Mechanical Engineers **705**
Amos Molded Plastics **326**
Armstrong Cork Co. **111**
The Auburn Manufacturing Co. ... **225**

B

Bakelite Co., a Div. of Union Carbide and Carbon Corp. **304, 306, 308**
Balsa Ecuador Lumber Corp..... **223**
Bart Laboratories Div., Bart Manufacturing Corp. **429**
Beemer Engineering Co. **233**
The Bellows Co. **329**
Boston Gear Works **514**
Burndy Engineering Co., Inc. **436**

C

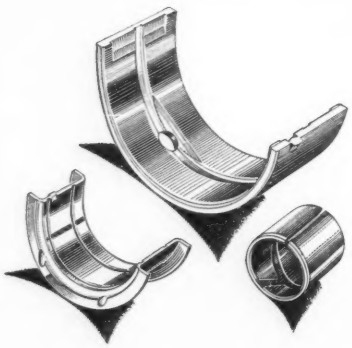
Camloc Fastener Corp. **129**
Cast Optics Corp. **113**
Central Foundry Division, General Motors Corp. **810**
Cerro de Pasco Corp. **236**
Chicago Allis Mfg. Co. **623**
Cleveland Cap Screw Co. **324**
Coating Products **231**
Colonial Alloys Co. **118**
Conolite Div., Continental Can Co. **217**
Controlex Corp. of America **1014**
Coors Porcelain Co. **502**
Corning Glass Works **226**
Cullman Wheel Co. **418**
The Cuno Engineering Corp. **403**
Curtiss-Wright Corp., Metals Processing Division **714**

D

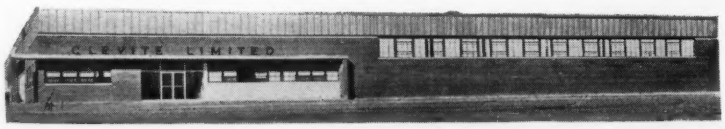
The Franklin Dales Co. **704**
Detroit Controls Corp. **230**
Diehl Manufacturing Co. **613**
The Dixon Corp. **906**
The Dobeckmun Co. **205, 207**
Doehler-Jarvis, Div. National Lead Co. **710**
E. I. du Pont de Nemours & Co., Inc. **343**
Durakool Inc.—Herma Seal Co., Inc. **520**
Durametallic Corp. **915**
Dynamic Gear Co., Inc. **801**

E

Eaton Mfg., Co., Reliance Div. **1020**
Elastic Stop Nut Corp. of America **106**
Electrical Manufacturing **234**

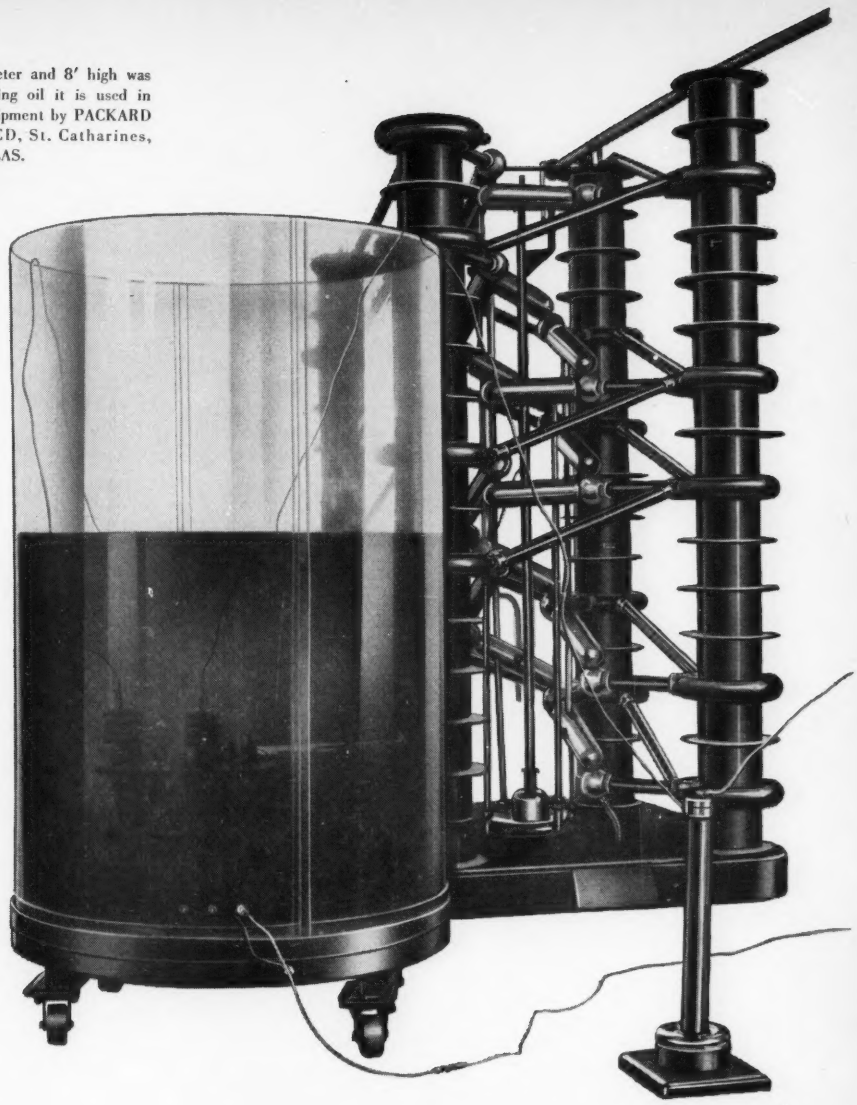


Clevite Limited, the only major Canadian manufacturer of sleeve-type bearings and bushings, regularly supplies outstanding engineering and field service to the automotive, farm equipment and appliance industries. If you use bushings in quantity, our split rolled bushings can mean improved performance and lower costs, particularly as compared with cast bronze types. Our engineers are at your service. Write or call Clevite Limited, St. Thomas, Ontario.



Canadian Subsidiary of Clevite Corporation, the World's Leading Producer of Sleeve Bearings and Bushings

This new testing tank 5′ in diameter and 8′ high was made from ½″ Plexiglas. Containing oil it is used in conjunction with surge testing equipment by PACKARD ELECTRIC COMPANY LIMITED, St. Catharines, Ontario. Another first for PLEXIGLAS.



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Patents

Some new ideas win protection in Canada

Removes discoloration Rubber company uses patent

CANADIAN PATENT No. 521,039 covers a method for removing the pink discoloration which develops in the kind of elastic yarn fabric that has a core of vulcanized rubber containing certain anti-oxidants. The patent issued on January 24, 1956 to Dominion Rubber Company, Limited of Montreal.

The discoloration results from the presence of symmetrical di-beta-naphthyl-para-phenylene diamine as an anti-oxidant, and it is removed by subjecting the dry article to the action of sulphur dioxide gas. After this treatment, excess acidic material can be neutralized by exposing the article to ammonia gas.

The inventor is David G. Slovin of Providence, Rhode Island.

• • •

Method improves grey iron in producing nodular iron

IMPROVED PHYSICAL properties in grey cast iron are claimed for a method of producing nodular iron described in Canadian Patent 520,974, which issued January 24, 1956 to the inventor, John A. Livingstone, of Pelham Manor, New York State. According to the patent, the secret lies in efficiently converting the free graphite in the grey cast iron into the nodular form. This is done by introducing into the molten iron an alloy containing magnesium and either cerium or mischmetal.

• • •

Patent new turbine chamber is cooled outside, inside

AN UNUSUAL combustion chamber construction for gas turbine engines or rocket motors is covered by Canadian Patent 519,908 of Armstrong Siddeley Motors Limited, which issued on December 27, 1955.

It features liquid cooling of the combustion chamber, which is made up of a stack of coaxial rings with their faces abutting. The stack is kept in place by an outer coaxial shell, and the rings have holes that register from ring to ring. Together the holes form a number of parallel channels running for the length of the wall and connected to a supply of liquid coolant.

Invented by Sidney Allen of Coventry, the arrangement not only cools the wall internally, but also provides skin cooling of the inside of the combustion chamber.

An annular groove between each pair of rings connects the various ducts, and apertures run from the grooves to the inside surface of the chamber so that a small amount of the coolant leaks out of the grooves and is carried down the inner wall surface of the chamber with the products of combustion.

• • •

RCA patent new method Will coat rough screen Patented here this year

RADIO CORPORATION of America has patented a new method of applying a metallic reflecting coating to the rough surface of a fluorescent screen.

As described in Canadian Patent 520,627, which issued January 10, 1956, the method includes the steps of wetting the surface with an excess of liquid, removing the excess, applying to wet surface a mixture of isobutyl methacrylate and a spreading agent in a suitable solvent, drying the screen surface and the film, and applying the reflecting metal coating to the film.

• • •

New silvering patent issued Coats glass, mica, quartz and other non-metallics

A NEW PROCESS for silvering glass, as well as other non-metallic surfaces like mica, quartz or synthetic resin, was patented in Canada on December 27, 1955, by International Standard Electric Corporation.

The patent, No. 520,013, describes the process as including steps of applying and then removing a solution of stannous chloride in hydrochloric acid to the surface to be coated and then mixing the usual reducing agent (formaldehyde) on the surface with a special solution of silver nitrate and ammonia that also contains an anionic surface active agent. A suitable surface active agent is the sodium salt of sulphonated lauryl alcohol.

Invented by Cyril F. Drake of London, England, the process is particularly suitable for silvering glass.

• • •

Design antenna assembly Gives polarized radiations

A SMALL-SIZE radio antenna assembly capable of producing directive, substantially plane polarized radiations was patented on January 10, 1956, by International Standard Electric Corporation of New York.

The patent, No. 520,596, names Frank J. Lundburg of East Orange, New Jersey, as the inventor of the antenna assembly, which includes a radiating antenna of small length relative to half a wave length at the operating frequency and a resonator formed by a pair of plates spaced on opposite sides of the antenna and connected by a cylindrical cage of conductive rods perpendicular to the plane of polarization of the antenna.

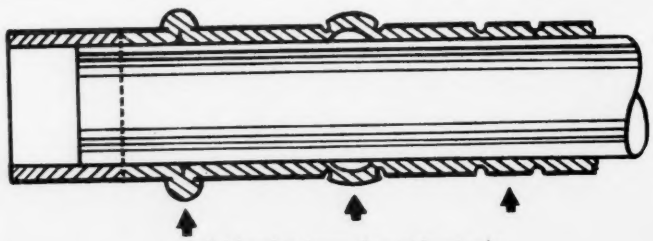
• • •

G.M. obtains new patent Forms bead outside of tube

GENERAL MOTORS Corporation of Detroit has obtained Canadian Patent 520,578 on a method of forming a solid peripheral bead or flange on the outside of a metal tube.

Invented by Stanley R. Carson, Dayton, Ohio, the method involves forming two parallel grooves a short distance apart on the outer surface of the tube so as to reduce the thickness of the tube in the grooves. The tube is then placed in a closely fitting mandrel and endwise force is applied to make the metal between the grooves flow outwardly in the form of a solid bead while the grooves themselves are moved together.

The illustration shows a tube before and after the bead or corrugation has been formed. It was issued January 10, 1956.



Solid bead is formed outside of tube.

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Phosphoric Acid	85%	200°F.
Sodium Hypochlorite	20%	200°F.
Sulfuric Acid	95.5%	70°F.
Pickling Solution (20% Nitric Acid, 4% Hydrofluoric Acid)		158°F.

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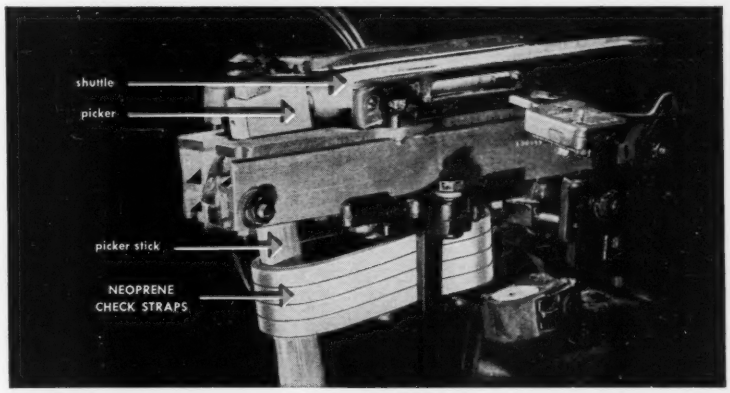
Natural Rubber HYPALON

Two tubing samples were filled with 98% (66°Be.) sulfuric acid for 24 hours at room temperature. Rubber deteriorated rapidly. HYPALON remained undamaged.

Newly designed NEOPRENE check straps outlast leather 3 to 1 on new high-speed textile looms



Neoprene's flex life, heat resistance reduce replacements, eliminate adjustments

A recent improvement in check-strap design promises to save the textile industry upwards of $3,000,000 annually. From the designer's viewpoint, this success is due to an imaginative approach—designing a three- or four-piece neoprene strap to replace a conventional one-piece leather strap.

This is the story. On high-speed looms the shuttle is hurled back and forth across the loom face at the rate of 200 times a minute. Every time the picker (see photo) throws or catches the shuttle, the picker stick slams into the check strap and stops. The combination of flexing, heat buildup and high weaving-room humidity made several adjustments of one-piece leather straps necessary to compensate for stretching, and limited their service life to 6 to 8 weeks. Many kinds of leather straps were tried, but leather still tended to distort, elongate, become fleshy and break.

The first and most important need was a check strap that wouldn't stretch. This was accomplished by plies of woven fabric and tire cord. But these strength-giving members had to be firmly bonded into a homogeneous strap in order to operate properly. Naturally neoprene was chosen as the best possible binder, because it had good adhesion to the fabric, was resilient and flex-resistant, and retained these properties in spite of heat and splash oil.

Performance confirms choice

And service confirmed the soundness of the manufacturer's choice of materials. The new straps lasted 3 times longer than the best leather, and stretch adjustments were completely eliminated.

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Engineering Show

(Continued from page 70)

for springs. **Minneapolis-Honeywell Regulator Co.** will be demonstrating precision switches. New speed reduction units will be shown by the **Boston Gear Works.**

Nylon screws and nuts with molded threads are to be shown by the **Weckesser Company.**

The latest in two-gear pumping will be shown by **George D. Roper Corporation. Stahlin Bros. Fibre Works Inc.** will be showing wiring duct to carry wire to electrical components mounted on a panel.

General Motors (Central Foundry Division) plan to show an actual reproduction of the equipment used to test castings by sound waves. The part to be tested at the show will be a universal joint yoke used in automotive drive shaft assemblies. The test mechanism is so delicate that it will reject castings with surface flaws which cannot be detected by any other device in addition to pointing out internal flaws which are invisible.

> Yet all this is just the start. Over 200 companies will be showing their products and ideas for the benefit of every type of industry. The value of the exhibits is estimated at $2 millions.

Last year, the organizers announced a show — then called it off. The reason for this set-back was the immense complexity of getting so much and so many under one roof which they found could not be overcome in time. So the big show was postponed. But this year it is very definitely on.

Without doubt this show will be as much of interest to Canadian engineers as to Americans. For this reason, **Design Engineering** is carrying a special invitation which applies to all readers and which will take you quickly and without formality into the show. This arrangement has been made possible by the co-operation of the organizers with **Design Engineering's** editors.

Note that the card should be taken with you to the show. Do not send it by mail. And before you go, fill it in using a typewriter to do so.

More exhibitors at the Show

(Bold figures are booth numbers)

Electro-Devices, Inc. **1124**
Electroflex Heat Inc. **524**
Ellis Associates **600**
Encyclopaedia Britannica **127**
Engineered Nylon Products, Inc... **616**
Eriez Manufacturing Co. **624**

F-G

Falstrom Co. **602**
Ferguson Machine & Tool Co. ... **715**
Flexible Tubing Corp. **209**
Foote Bros. Gear & Machine Corp. **140, 142**
Formsprag Co. **316**
Frenchtown Porcelain Co. **215**
Fromson Orban Co., Inc. **229**
The Garlock Packing Co. **214**
General Electric Co. **325**
General Findings & Supply Co..... **117**
The General Fireproofing Co. **319**
The Glastic Corp. **614**
The Globe Co., Grip-Strut Div. ... **724**
Gries Industries, Inc. **235, 237**
Gries Reproducer Corp. **235, 237**
Groov-Pin Corp. **110**

H-I

The H. M. Harper Co. **1004**
Heim Co. **320**
Heli-Coil Corp. **114, 116**
Hermes Plastics Inc. **107**
E. F. Houghton & Co. **307**
Howard Industries, Inc. **723**
Hunter Spring Co. **219**
The Improved Seamless Wire Co. **424**
Industrial Design Magazine **435**
Industrial Equipment News **722**
Instrument Specialties Co., Inc. ... **120**
International Balsa Corp. **239, 241**
International Packings Corp. **408**
Kennametal Inc. **313**
Kimberly-Clark Corp. **905**

L-M

L & L Manufacturing Co. **135**
L. O. F. Glass Fibers Co. **428, 430**
The Lamson & Sessions Co. **615**
The Lancaster Lens Co. **406**
La Salle Steel Co. **204, 208**
Leach & Garner **117**
Lehigh Chemical Co. **213**
Lignum-Vitae Products Corp. **239, 241**
Linde Air Products Co. **820**
Linemaster Switch Corp. **314**
The Louis-Allis Co. **334, 336**
Lovejoy Flexible Coupling Co. **434**
Machinery Magazine **823**
MacLean-Fogg Lock Nut Co..... **706**
Magnaflux Corp. **601**
Mallory-Sharon Titanium Corp. .. **713**
Manheim Manufacturing & Belting **433**
Marquette Metal Products **605**
Materials & Methods **303**
Mechanical Industries Production .. **920**
Merkle-Korff Gear Co. **415, 419**
Micro-Balancing Inc. **102**
Micro Switch Div. of Minneapolis-Honeywell Regulator Co. **709**
Minnesota Mining & Mfg. Co. **606**
Multiple Extrusions Inc. **125**
Mycalex Corp. of America **108**

N-O

National Vulcanized Fibre Co. ... **212**
Nelson Stud Welding **124, 126**
Newark Wire Cloth Co. **432**
New Hermes Engraving Machine .. **107**
North Shore Nameplate Inc. **1001**
O'Sullivan Rubber Corp. **414**

P-R

The Penton Publishing Co. **425**
Pic Design Corp. **138**
The Polymer Corp. of Penna. **922**
Post Machinery Co., Electronic Products Div. **902**
Potter & Brumfield **330**
Product Engineering **339**
Products Research Co. **805**
Reliance Electric and Engineering .. **220**
Reynolds Metals Co. **312, 407, 411**
M. H. Rhodes, Inc. **1000**
Rigidized Metals Corp. **203**
Roehlen Engraving Works, Inc. ... **338**
Roller Bearing Co. of America ... **504**
George D. Roper Corp. **426**

S-T

Scovill Manufacturing Co. **716**
Simmons Fastener Corp. **115**
Snow-Nabstedt Gear Corp. **702**
Sparkler Manufacturing Co. **1102**
Stahlin Brothers Fibre Works, Inc. **703**
Standard Pressed Steel Co.... **333, 335**
Stearns Magnetic Inc. **423**
Stokes Molded Products Div., The Electric Storage Battery Co. **510**
Stow Manufacturing Co. **131**
Stratos Div., Fairchild Engine & Airplane Corp. **402**
Stromberg-Carlson Co. **128**
Sweet's Catalog Service **141**
Sylvania Electric Products Inc. **311**
Teleflex, Incorp. **816**
Thomas Publishing Co. **722**
Thomas' Register **722**
Thomson Industries, Inc. **101**
Thriftmaster Products Corp. **101**
Tinnerman Products, Inc. **909**
Titeflex, Inc. **503**
Toyad Corp. **227**
Tuttle & Kift, Inc. **211**

U-V

U. S. Automatic Corp. **123**
U. S. Royalite Div. of United States Rubber Co. **130, 132**
The U. S. Stoneware Co. **240**
Veeder Root Incorporated **412**

W-Y

Wagner Electric Corp. **437**
Warner Electric Brake & Clutch Co. **721**
The Weatherhead Co. **1106**
Weckesser Co. **133**
Whitney Chain Co. **516**
Wolverine Tube Div., Calumet & Hecla, Inc. **422**
The Yale & Towne Manufacturing Co. **121**

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#5100 *(external)*

Tapered design principle permits rings to maintain constant circularity and pressure against bottom of groove.

INVERTED

#5008 *(internal)*

#5108 *(external)*

Inverted construction provides uniform protruding shoulders while maintaining constant circularity when installed in groove.

for taking up end-play

BOWED

#5001 *(internal)*

#5101 *(external)*

Bowed construction permits **resilient** take-up of end-play.

BEVELED

#5002 *(internal)*

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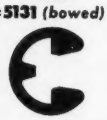
Beveled construction permits **rigid** take-up of end-play.

for radial assembly

E-RING

#5133
#5131 *(bowed)*



Radially applied. Provides large shoulder on small shaft diameter. Bowed version provides take-up of end-play.

CRESCENT

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Applied radially over shaft. Secure against impact and vibration.

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File

New booklets and books written for you

Fastener data published Produce 52-page stock list

A COMPREHENSIVE 52- page stainless fastener stock list and data book has been published by **Allmetal Screw Products Company Inc.** Thumb-indexed for easy reference, it is divided into two main sections: stock list and specifications of basic fastening devices, and engineering tabular data.

The first part shows specifications relating to head, shank and thread dimensions of forty basic fastening devices including bolts, screws, nuts, washers, rivets, pipe fittings and fasteners. Detailed stock listing for each type includes availability according to diameter, length, thread, material and form. Each device is also illustrated to indicate dimension references.

The second part consists of engineering data relating to the composition, properties, weights of stainless steels (206)

• • •

Tool engineers help selves Compile new ASTE Index

PUBLICATION of a revised Data Sheet Numerical Index, adapted from the U. S. Standard Commodity Classification System has just been completed by the National Standards Committee of the **American Society of Tool Engineers.**

ASTE pioneered in compiling and publishing a sound and systematic classification of products of interest to the tool designer. Designed by tool engineers for tool engineers' use, the ASTE Index is an invaluable asset in selecting, filing, classifying and comparing all available tool engineering products quickly and accurately.

While the Index is primarily intended to establish a comprehensive system by which ASTE Data Sheets and related information may be filed, it is not a listing of available Data Sheets. It serves a dual purpose, since it can also be used to number and file the accumulated mass of engineering information and data. Articles, tables, or data can be numbered and filed for easy reference.

The revised Index will incorporate more than four times as many product entries and a complete breakdown of items within the category of special interest to the tool engineer.

Although numbering is different, the Index works in the same manner as the decimal system used by libraries the world over. Every item or class of item is given a specific seven-figure number. The first two numbers represent the group. This is followed by a dash and five more numbers which break down systematically into subclassifications. Under each group there are 90,000 classified and interrelated numbers available.

The ASTE Index comes in two parts: The Numerical Listing — which is abridged, but shows the basic structure and logic of the ASTE Edition of the U. S. Standard Commodity Classification, and The Alphabetical Listing — which is merely a cross reference index of the same numerical material expanded for specialized use. (207)

• • •

Discuss PVC protection Avoid material confusion

A NEW BOOKLET available from **Kaykor Industries, Inc.** tells how to choose the best polyvinyl chloride protection for any corrosive treatment.

The three most commonly used types of PVC protection are covered individually, attention being paid to physical and chemical characteristics, advantages and disadvantages, and the best applications. In addition to unplasticized polyvinyl chloride structural material and flexible PVC lining, space is devoted to the recently introduced flexible-rigid polyvinyl chloride laminates, which combine the inertness of the unplasticized with the easy application of the flexible types.

Not intended as a substitute for the Engineering Bulletins which the company also publishes, the booklet should do much to eliminate confusion as to the proper material for a job. (208)

• • •

Design new aero valves Engineers kept informed

A MANUFACTURER of precision hydraulic and pneumatic aircraft components **Aircraft Products Co.** has issued a Data Sheet on its new Series 6000 line of 3-way solenoid operated selector valves for 3000 psi hydraulic service.

A two-page color sheet describes and illustrates the valves which handle 85% higher flows than conventional models and permit flow in any direction.

Charts, tables and specifications cover port sizes, rates of flow, solenoid voltage and other characteristics. (209)

Book Department

Engineering Drawing and Geometry. THIS COMPREHENSIVE book on the many facets of engineering drawing is quite the best that the reviewer has seen on the subject, as would be expected from experienced engineer-authors like **Randolph P. Hoelscher** and **Clifford H. Springer.** Both of them are well known for their contributions to American drafting standards.

Since this text is designed for engineers, thoroughness in the understanding of principles has been emphasized rather than manual skill. Although the engineer must know what is required in technique to produce a satisfactory drawing for reproduction, the authors have not attempted to teach perfectionism in lettering and manual skill. It is from the viewpoint of developing an engineer rather than a draftsman that the subject matter has been presented.

All the theory in descriptive geometry necessary for the successful solution of problems in design and drafting has been included in a few chapters. These have been so arranged that they may be used in a combined and integrated course in both drawing and descriptive geometry or in separate courses if so desired. One text with a uniform system of nomenclature is a distinct advantage over two books with different systems.

The text has not been confined to the concepts of machine drawing but treats the subject from the broader base of engineering usage as a whole. Thus, the first treatment of dimensioning is limited to practices which apply in all fields, and the subject of tolerances and limit dimensions is treated later with special reference to production drawings for interchangeable assembly. The latest concepts, such as geometric and positional tolerancing, have been adequately presented.

A page size the same as Design Engineering has been adopted to permit the use of larger illustrations where necessary for clarity and to make the book lie open on the table without weights.

Among the special features, axonometric projection is covered, as well as standard isometric and oblique. There is up-to-date material on design for interchangeable assembly, covering limit dimensioning, geometrical and positional tolerancing.

The chapters on structural drawing, architectural drawing and a host of other topics are complete enough for advanced courses or reference. The approach to dimensioning and shop practice is new and in accord with modern trends. The appendix offers all the tables needed in the drafting room. Problem material is designed to make students use their theory.

In short, an excellent book, published by John Wiley & Sons at $8.00 and worth every cent it costs.

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1
Line-to-line seal between ERMETO sleeve and fitting body.
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Line-to-line seal between tube and cutting edge of patented ERMETO sleeve.

Bothered by Vibration? Leakage? Pressure?

WEATHERHEAD ERMETO®

Now you can get a positive, leakproof, vibration-resistant seal for any pressure, low to extremely high—*without flaring and using a wrench as your only tool.*

With the patented ERMETO design, the sleeve actually shears a groove into the outer surface of the tube when the nut is tightened. The result is a positive seal, for the life of the tube, regardless of how often the joint is disassembled and reassembled. Write for ERMETO Catalog E-1457.

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Canadian-designed articles shine at NIDC

Our best showing in Awards' four years — We take 49 "design awards" against 18 of foreign design

MORE CANADIAN-DESIGNED articles received National Industrial Design Council (NIDC) Awards this year than in the competition's four-year history.

Judges, who selected winners from a total of 600 entries by 170 Canadian producers, chose 67 articles entered by 52 manufacturers. Of these, 49 articles were designed by Canadians and the other 18 were of foreign design.

By comparison, in 1955 just over half the Awards went to Canadian-designed articles. For the first time, only articles which appeared on the market within the past 18 months were accepted for competition. Products which had won Awards previously were also ruled out.

The Awards, granted to Canadian products rated as outstanding in good design on the basis of appearance, usefulness and consumer acceptability, permit the winning firm to use a "design award" label on the product that is honoured. Special certificates are given to the designers in each case, but neither the company nor the designer receives a cash award.

Clean lines won Award for rangette.

The judges' panel this year reported a continuing improvement in furniture design, and they were particularly impressed with refinement and lightness.

Those who judged this year's competition were: J. B. Ferguson, past president, Canadian Manufacturers' Association, Rock Island, P.Q.; E. A. Allcut, professor of mechanical engineering, Toronto University; J. S. Luck, ACID Staq designer, Aluminum Laboratories, Kingston, Ontario; W. M. Murray, president, Canadian Retail Federation, Ottawa, Ontario; Mrs. John Butterfield, chairman of the consumer research section, Canadian Association of Consumers, Toronto.

Of the many outstanding designs to receive awards, Design Engineering editors make particular note of three.

The Canadian Beauty Electric Rangette designed by the staff of the Renfrew Electric and Refrigerator Co. Ltd., Renfrew, Ontario, is marked by its clean lines — an overall simple design. A straight plug-in appliance, it operates on 120 volts at 1500 watts. The oven element is interchangeable and the oven itself is porcelain throughout. Door handles have been designed with a functional slope for easier opening.

Weight of the rangette is 100 lbs. and its dimensions are 34½ in. high, 22½ in. wide, and 17¼ in. deep. Retail price of the steel and porcelain, white rangette is $123.95.

Chief designer of the company, Douglas M. Wheeler commented favorably on the Awards which, he said, not only encourage original Canadian design but also inject interest saleswise.

From the Northern Electric Co. Ltd., Belleville, Ontario, the "Magnaphone" intercom master station and substation attracted high interest from the panel. Of compression-molded plastic, fashioned by General Tire of Welland, the case of the master is 13 in. long, 6¼ in. high and 7¼ in. across. It is made of urea formaldyhyde.

The smaller substation is 7½ in. long, 6½ in. high, and 5¼ in. across.

All uses for intercoms are covered with the magnaphone arrangement, which is reportedly simple to operate and easy to instal. The master unit uses leaf-type telephone keys for all switches which provide long life.

We make an inexpensive lighter too.

Hooked-up, the regular telephone lines can be used between master stations. The range is about 15 miles.

Each calling station has complete control and it can leave the call registered or take it out.

While two master stations may call one another, or a master call a substation, or vice versa two substations cannot call one another.

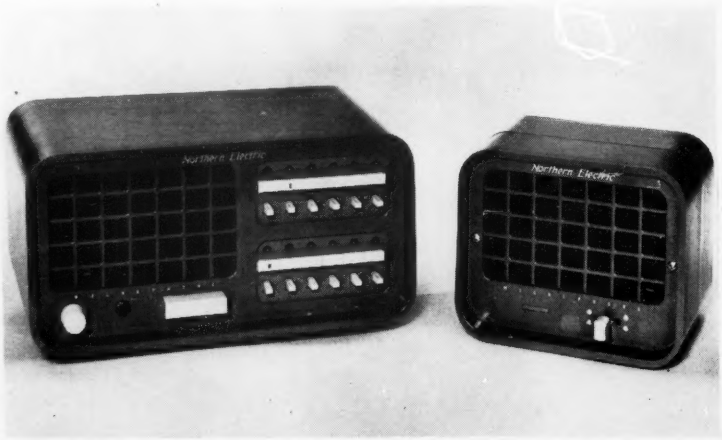
In many cases the cost of wiring is far more than the value of intercom equipment, but the Magnaphone system can be used with the existing telephone hook-up to overcome this.

An additional design feature is a pleasant chime instead of a buzzer.

The master station is priced at $225.00 and the substation retails for $30.40.

A non-automatic type of lighter, designed by Orr Associates, Toronto, for the L. E. Waterman Pen Co. Ltd. and made to sell competitively with Japanese and other foreign lighters, is one of a series. The semi-automatic and the automatic are still in the design stage.

The body is die-cast and the top flips up easily for access to the flint wheel. Attractively crinkle-finished, it sells for $3.45. ★



Northern Electric's master-station, sub-station intercom was another winner.

Photo courtesy Standard Desk Manufacturers Ltd., Montreal.

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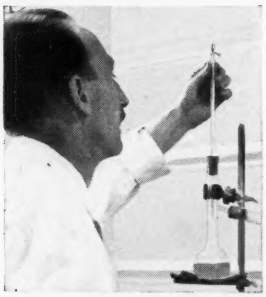

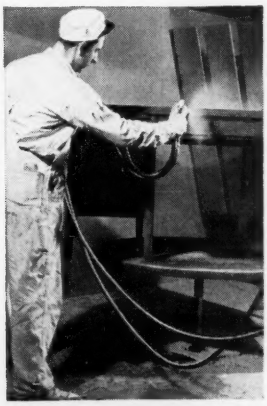

Standard Desk craftsman spraying C-I-L Hot Spray Satin Lacquer on office desk.

Few things contribute so much to a sense of well-being and efficiency in an office as *enduringly* attractive furniture. Few things, too, are so reassuring to those who *buy* the furniture as the knowledge that the finish will stand hard wear, and give excellent service for money invested.

Standard Desk Manufacturers Ltd. is well aware of this — that's why they use C-I-L Hot Spray Satin Lacquer to finish the modern desk pictured here. They know C-I-L Finishes give their products a surface *unexcelled* for scratch and mar-resistance.

Then, think of the *flexibility* that C-I-L gives them! C-I-L makes over 5,000 Industrial Finishes. Its laboratories — the largest and most modern in Canada — have unrivalled facilities for research as applied to specific finishing problems.

If *you* want the best in finishes to enhance the appearance and endurance-value of *your* product—no matter what it is—remember There's a C-I-L finish available.

For Technical Information Bulletin No. 62 — complete C-I-L Furniture Finishing Systems — write: Canadian Industries Limited, Paints Division, Dept. 105, Box 10, Montreal, Que.

industrial finishes

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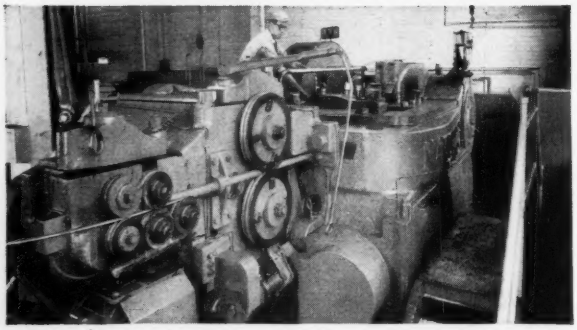

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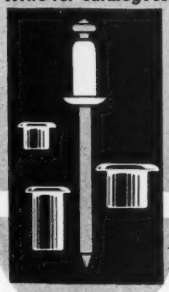

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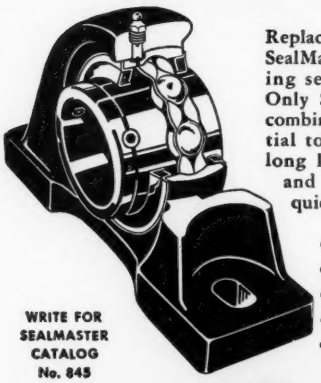

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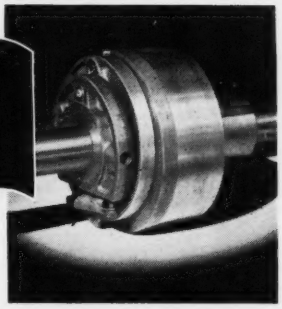

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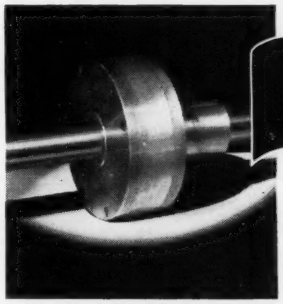

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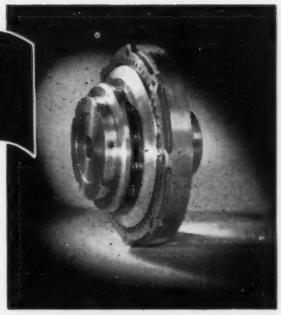

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Fine Grinding

(Continued from page 47)

that you have in an alternating current motor and 2. to be able to vary the speed. A variable speed motor is desirable for the utmost accuracy because if the grinding wheel is not grinding properly, the speed can be increased or decreased for better operating conditions.

The grinding wheel on the OD grinder is dressed at a higher speed than is used when grinding. The motor should be in perfect balance, and frequent balance checks of the motor should be made.

Centres on the grinder should be in line in all directions in order to get true roundness. It is possible to get a good grind only when centres are absolutely in line. If centres are not in line, the work usually becomes concave. Centres on the machine have to be adjusted so that just enough pressure is exerted to take up all motion but light enough to avoid any bending of the work piece.

The tail stock centre must fit closely yet must be free enough to move.

To assure the maximum grinding machine accuracy the wheel centre must be exactly the same height as the machine's centres. The OD machine is equipped with accumulators to dampen the pulse from the hydraulic system. Engineers accomplished this by installing accumulators which maintain a constant pressure in the hydraulic system.

The grinding wheel should cut free and must avoid sending free particles from the wheel to the work piece. The wheel is dressed very carefully, with sharp corners rounded off by hand and all loose grits removed from the wheel.

The diamond holder, used in the dressing operation, is very sturdy and as nearly free of vibration as possible. The sharp conical point diamond must be on the centre of the wheel.

Pulleys on the machine must run absolutely true and in perfect balance. Pulleys should be accurate to between three to five ten-thousandths of an inch.

The floor of the precision grinding room at Timken is a solid concrete slab reinforced with steel and 24 to 36 in. thick. The walls and girders are detached from the grinding room floor to minimize vibration.

To assure constant working and measuring standards, temperature in the master gauge grinding department and the adjacent gauge measuring laboratory is maintained between 68 and 70 degrees Fahrenheit, while humidity is kept at 45%.

The rewards for the painstaking precision built into company's precision grinders have been substantial.

The company has invested enormous sums in master gauges for the obvious purpose of producing an extremely accurate product. With the increased grinding accuracy have come even more accurate gauges. The life of gauges ground on the new precision grinders is much greater. Fewer gauges are now required.

Because of the previous short life of gauges, the tool room was constantly busy making new gauges. This often proved to be a production bottleneck. With the installation of the precision grinding machines the production bottleneck caused by too few accurate gauges has been totally eliminated.

The new precision grinders at Timken are phenomenal, even in a company where tolerances of ten millionths of an inch have become commonplace. ★

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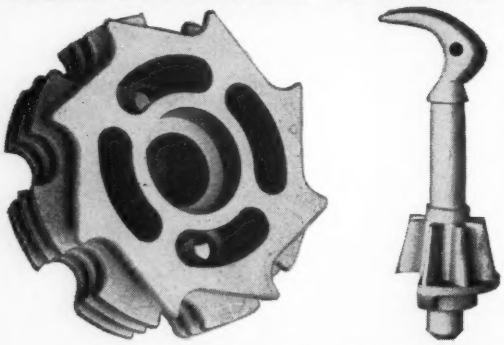

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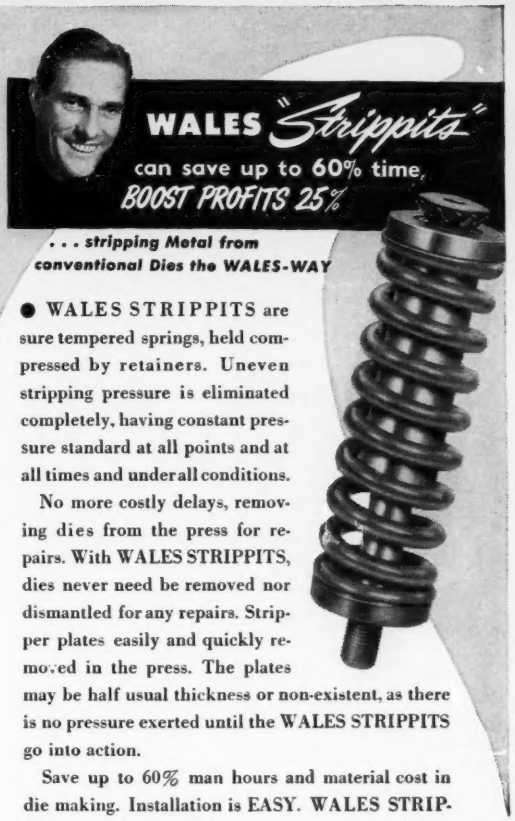

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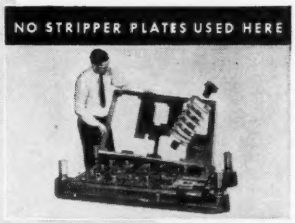

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Editorial

To go places industry needs its leaders

IT COULD BE that Canadian industry is about to start going places. Not just in terms of quicker, bigger deals—but in terms of independence and prestige. How is this so?

In September, last year, **Design Engineering** asked, "Where are the men who will start a new journey toward the better, safer prosperity that comes from independence . . .? It is time they came forward."

The good news is that they are doing so. Here is the reason why industry may be shifting into a higher gear.

Our industry has been deplorably short of leadership in the past. There have been few great names to follow. Canada is said to have some 40 millionaires; but how many of their names are known outside their own conference rooms? Three? Perhaps four? Certainly the big majority have been anonymous. Yet all other great industrial nations have had leaders. They have had their Henry Fords, their de Havillands, their W. O. Bentleys, their Anthony Fokkers, their Citroens and their Krupps. These men were more than shrewd investors; they were leaders. They showed, colorfully and bravely what could be done. When lesser men followed their example the strong industries of the world were built.

More than balance sheets and economic theory, it is men who build (or lose) an industry. Canada has been short of men of the right calibre. Now this may be changing.

The Gordon Commission has been a rare and fine opportunity for the top men in industry to set out the facts of manufacturing life. It offered a choice between the narrow view pleading special favors for the man behind the brief; and the broad view aimed to help the commission with frank objectivity.

Reports of the Commission's sessions show that there were plenty of narrow views. But there were also some outstandingly valuable briefs put in by men of stature for industries of importance.

Two, in particular, have come to **Design Engineering's** notice as being outstanding contributions. These came from K. R. Patrick, of Canadian Aviation Electronics Ltd.; and R. M. Brophy of Philips Industrial Development Company.

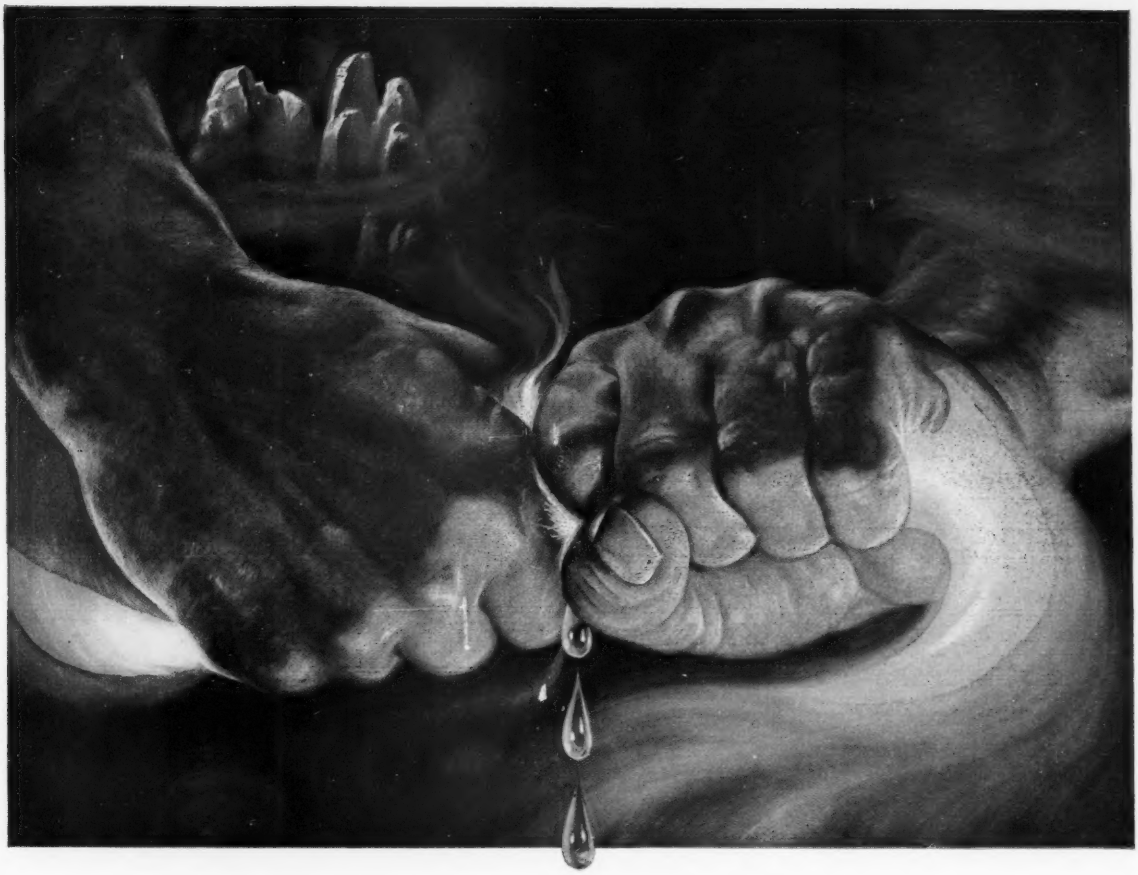
Both these eminent, experienced men strongly stressed the need for more research and development work in Canada.

And Mr. Patrick was able to point out that his company is the largest Canadian owned electronics company in business—adding that out of 24 TV manufacturers listed in Canada 20 are foreign controlled. In the face of intense competition from the U. K. and the U. S. this company has grown safely to maturity, contributing much to Canada while doing so.

In this fact, alone, lies a lesson for those who feel that there is no alternative to a license from below the border.

Mr. Brophy's brief urged that Canadian subsidiaries of foreign companies, must be given a share of research programs. He cited arrangements between his own company and its Dutch affiliate to prove that what he said made sense.

When men as respected as these urge the case for independence there is reason to hope that others may follow. Perhaps Canadian industry is going to finish up standing on its own feet after all.



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THESE FORCES OF NATURE are used by industry in making so many of the things we take for granted today. The electric arc furnace—6,000 degrees hot—is the birthplace of alloying metals that go into stainless steel and other fine steels. Oxygen, so vital to medicine and industry, is extracted from air made liquid when cooled to more than 300 degrees below zero.

ETHYLENE GAS SQUEEZED under pressure of 15 tons per square inch changes into polyethylene. This remarkable plastic is used to make such familiar things as unbreakable nursing bottles, squeeze-spray containers, and transparent wrappings. Exposing refinery gas to terrific pressures and the 'nothingness' of vacuum have been key steps in making hundreds of new chemicals during the last 20 years.

THESE ARE BUT A FEW examples of the work of Union Carbide Canada Limited and its Divisions in using the forces of nature to create products and processes essential to the progress of industry.

FREE: *Learn how ALLOYS, CARBONS, CHEMICALS, GASES, and PLASTICS improve many things that you use. Ask for 'Man-Made Miracles' booklet DE-1.*

UNION CARBIDE CANADA LIMITED

2221 YONGE STREET — UCC — TORONTO 7, CANADA

OPERATING DIVISIONS

ALLOYS AND METALS	CARBON PRODUCTS	CHEMICALS	INDUSTRIAL GASES	PLASTICS
Electro Metallurgical Co. Welland	National Carbon Company Toronto	Carbide Chemicals Company Montreal	Linde Air Products Co. Toronto	Bakelite Company Belleville

Brick plant conveyor operates trouble-free for years—on 1000 TIMKEN bearings

UNITED STEEL CORPORATION reports that Canadian brick plant conveyors, such as illustrated here, have been operating trouble-free for years. And one of the reasons is that the idlers are equipped with Timken tapered roller bearings—1000 of them.

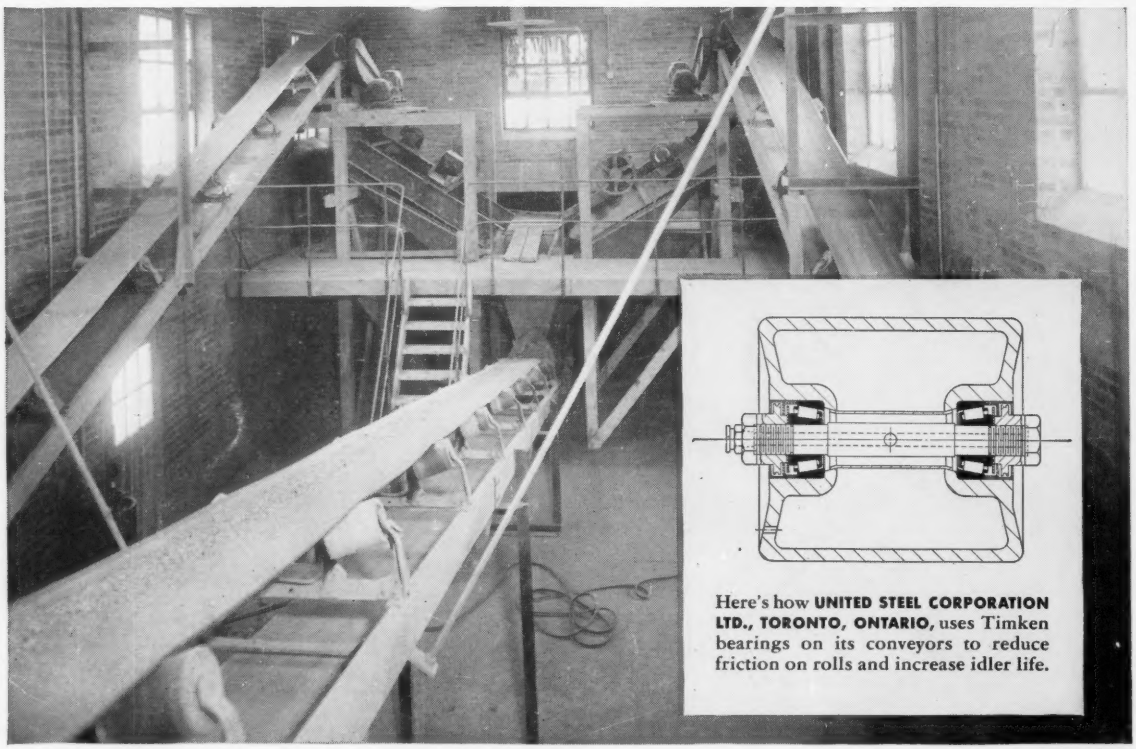
This means there's less friction on the rolls. It means increased idler life. The result: trouble-free operation and continuous production, with minimum maintenance.

There are other reasons why so many heavy-duty long-lived conveyors are equipped with Timken bearings:

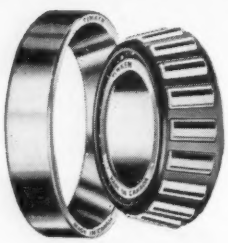
1. The Timken bearing is the only tapered roller bearing proved by 15 years or more of service in heavy-duty conveyor installations.
2. Full line contact between rollers and races gives Timken bearings high load capacity.
3. Long life lubrication. Not just lubricated for "life", but lubricated yearly, or, as conditions require to insure *longer* life. Fresh lubricant ends any chance of gummy, sticky, jammed bearings.
4. Longer roller and belt life. Less sliding and scuffing between idlers and belt.
5. Friction minimized. Timken bearings' true rolling motion and extremely smooth surface practically eliminate friction.
6. Maintenance reduced. Long life and dependable performance of Timken tapered roller bearings cut maintenance to a minimum.

To be sure you get all these advantages, specify Timken bearings on equipment you build or buy. You'll find the "Timken" trade-mark on every bearing made by The Timken Roller Bearing Company. It will pay you to insist on it. The Timken Roller Bearing Company, Canton 6, Ohio, U.S.A. **CANADIAN PLANT:** St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Here's how **UNITED STEEL CORPORATION LTD., TORONTO, ONTARIO,** uses Timken bearings on its conveyors to reduce friction on rolls and increase idler life.



TIMKEN *Made in* CANADA

TRADE-MARK REG. IN CANADA AND U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

FOR CANADIAN INDUSTRY

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ⊕ AND THRUST →⊕← LOADS OR ANY COMBINATION →✳←